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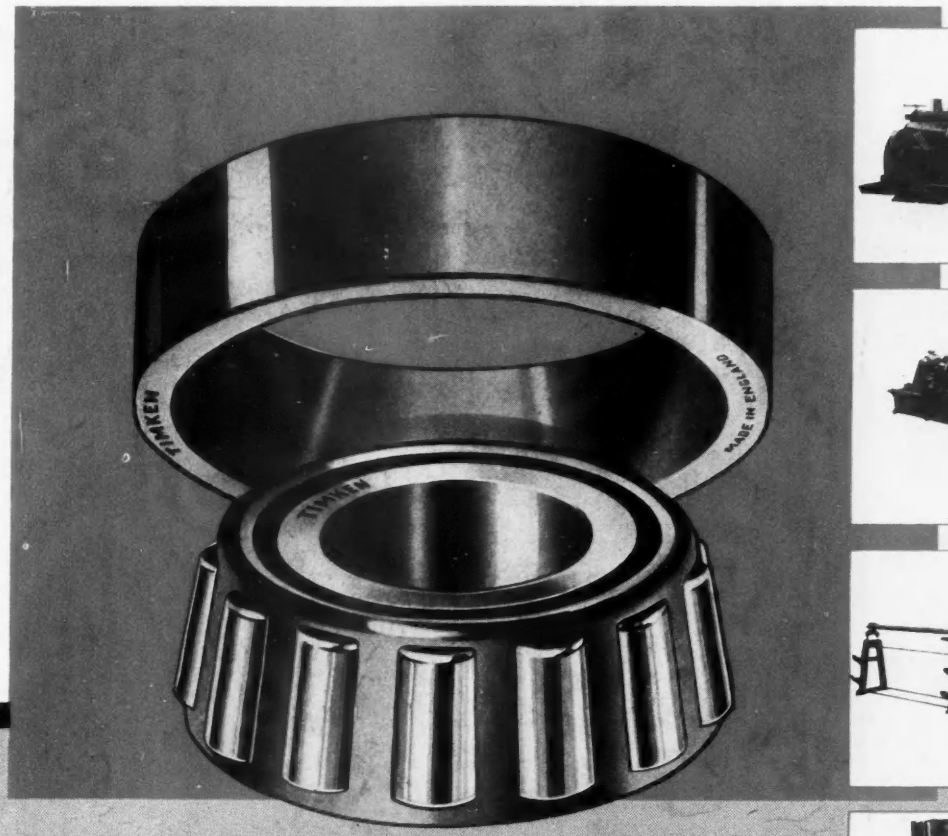
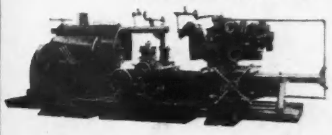



Alfred Herbert Combination Turret Lathe



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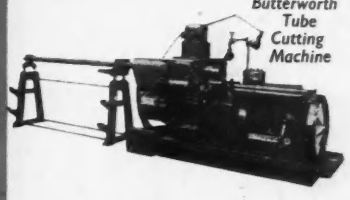
Butterworth Tube Cutting Machine



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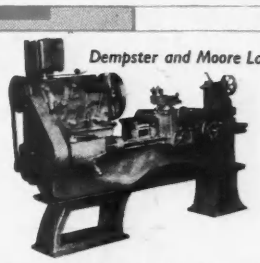

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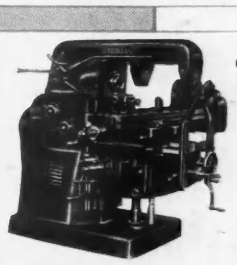
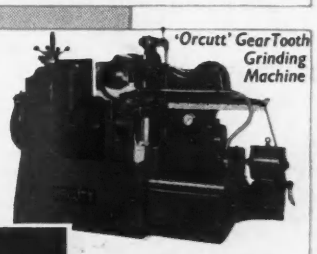
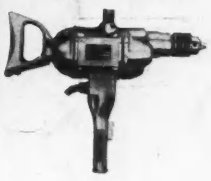


'Orcutt' GearTooth Grinding Machine



Black & Decker Heavy Duty Electric Drill



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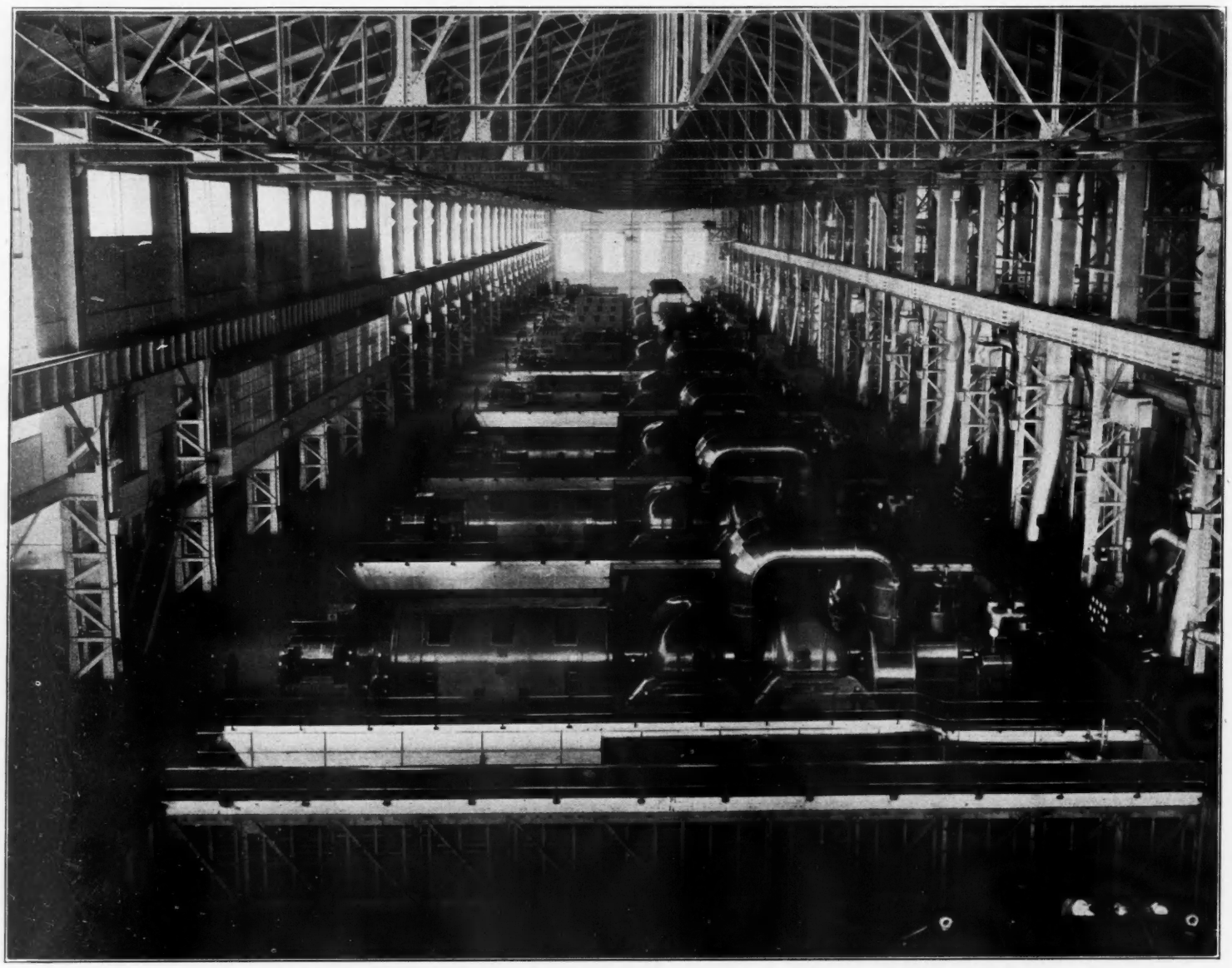

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PIPES

# A Seven-Day Journal

## The Parliamentary and Scientific Committee

AT the House of Commons on Wednesday, January 31st, a meeting of the Parliamentary and Scientific Committee was held under the chairmanship of Major H. A. Proctor, who presided in the absence of Captain L. F. Plugge, the chairman of the Committee. Among those present were Mr. W. R. Diamond, Dr. J. Vargas Eyre, of the Distillers Company, Mrs. R. Fremlin, of the Association of Scientific Workers, Mr. W. F. Higgs, Mr. Henry Haslam, Professor W. B. Holman, of the Royal School of Mines, Mr. O. H. Howarth (representing Professor Allan Ferguson of the British Association), Dr. J. O. Cutter, of the Oil and Colour Chemists' Association, Mr. R. H. Morgan, Mr. S. F. Markham, Mr. R. F. Maitland, of the Institution of Structural Engineers, Mr. R. B. Pilcher, of the Institute of Chemistry, and Dr. W. R. Woolridge, of the London School of Hygiene and Tropical Medicine. It was announced by the Secretary that the following bodies have now definitely agreed to support the new committee :—The Association of Scientific Workers ; the Institution of Chemistry ; the British Association of Chemists ; the National Veterinary Association ; the Institution of Structural Engineers ; the Institute of Marine Engineers ; the British Association for the Advancement of Science ; the Institution of Mechanical Engineers; the Institution of Gas Engineers ; the Pharmaceutical Society of Great Britain ; the Institute of Fuel ; the Thames Barrage Association ; the Oil and Colour Chemists' Association ; the Institution of the Rubber Industry ; the Association of Applied Biologists ; and the Universities Federation for Animal Welfare. The following Members of Parliament have agreed to become members of the Committee :—Captain Plugge ; Colonel Baldwin-Webb ; Mr. S. F. Markham ; Mr. Salt ; Mr. Alan Chorlton ; Dr. Haden Guest ; Sir John Graham Kerr ; Mr. R. R. Stokes ; Sir Murray Sueter ; Mr. David Adams ; Mr. Henry Haslam ; Sir Ernest Graham-Little ; Major Proctor ; Mr. Kenneth Pickthorn ; Mr. W. Higgs ; Mr. R. H. Morgan ; Mr. W. R. Duckworth ; and Mr. I. C. Hannah. It was agreed to give all possible support to affiliated scientific and technical bodies, in ensuring fair treatment for scientific and technical workers in connection with military service.

## Export Trade Council

IN the House of Commons on Thursday, February 1st, Mr. Chamberlain, in reply to a Labour proposal for a Minister of Economy, rejected the proposal on the ground that the existing machinery worked satisfactorily. Referring to export trade, he said that the Board of Trade was well fitted to co-ordinate the needs of our export trade, to construct export trade programmes, and to ensure that provision was made in good time to see that those programmes were carried out. He announced that the new President of the Board of Trade would preside over a new Export Trade Council, consisting of a number of leading business men, some of whom were prepared to give their full time and service voluntarily to the Government to assist in organising our export trade in detail. The Council would also include leading members of the trade union movement. In addition, Lord Stamp would be a member of the Council and there would be senior representatives of the Treasury and the Ministry of Supply. The Ministry of Economic Warfare would also have a representative on the Council in view of the difficulties which sometimes arose for British exporters through measures taken in economic warfare. The Council would have at its disposal the Department of Overseas Trade and the Industrial Supplies Department of the Board of Trade. It had been ascertained that the new Council would have the active assistance, approval, and support of industry generally. We might look forward to a very considerable concerted drive in order to take the fullest advantage of the opportunities for the development of the export trade which are open to us. We had to try to provide whatever was necessary to enable us to meet the demands which were being made upon us from many quarters, and particularly from quarters which formerly did trade with Germany. The members of the Export Council, over which the President of the Board of Trade will preside will be :—Sir Clive Baillieu, K.B.E., C.M.G., O.B.E., chairman of the National Smelting Company, Ltd., and director of other companies ; Mr. S. R. Beale, past-president of the Association of British Chambers of Commerce; Mr. John Brown, general secretary, Iron and Steel Trades' Confederation ; Mr. F. D'Arcy Cooper, chairman of Lever Brothers and Unilever, Ltd.; Mr. Edwin Fisher, chairman of Barclays Bank, Ltd.; Mr. M. Hodgson, J.P., secretary of the Boilermakers Society ; Lord Hyndley, G.B.E., commercial adviser to the Mines Department ; Sir Cecil Weir, K.B.E., M.C., chairman of the Export Trade Committee of the Association of British Chambers of Commerce ; Lord Stamp, G.C.B., G.B.E., adviser on Economic Co-ordination ; Sir Frederick Phillips, K.C.M.G., C.B., Treasury ; Sir Frederick Leith-Ross, G.C.M.G., K.C.B., Ministry of Economic Warfare ; Mr. W. Palmer, C.B., Director-General of Raw Materials, Ministry of Supply ; the Controllers or Deputy Controllers of Cotton and Wool, and, when required, a representative of the Foreign Office.

## Producer Gas Vehicles Committee Report

ON Monday, February 5th, the report of the Emergency Conversion of Motor Vehicles to Producer Gas Committee was published. The committee, of which Sir Harold Hartley is the chairman, includes technical representatives of several road transport operating companies. The report outlines the research work which the committee has supervised and gives an illustrated description of a producer and trailer unit designed by them. The Mines Department announces that about 25 firms have been granted licences to manufacture equipment conforming to the committee's design. In its conclusions the committee states that provided suitable equipment and fuels are used producer gas can be considered as a practical alternative fuel for motor-vehicles, and can be recommended for use in an emergency for certain types of road transport. The design is simple but satisfactory performance is dependent on strict adherence to the leading dimensions given and good workmanship in manufacture. The use of the producer on a trailer would generally obviate the complications and costs arising from mounting the producer directly on the vehicle, but the method to be preferred is dependent upon individual circumstances. The committee has obtained good results using sisal tow, and also oiled coke followed by sisal tow, as filtering media. Fuel costs under present conditions should be appreciably less than with petrol. Fire risks and danger of asphyxiation are thought to be small provided reasonable precautions are taken. Gas producer vehicles can be used for local delivery work, though they are much more suitable and economical on long-distance work. It is of the utmost importance that suitable fuels only, such as low volatile anthracite and certain low temperature cokes, should be used. Sufficient anthracite for several thousand vehicles can be made available at short notice. If certain plant were installed at low-temperature coke works, sufficient fuel should be available for about 10,000 vehicles. There is reason to hope that the potential fuel supply will be largely increased by the addition of certain types of coke, should experiments fulfil their present promise.

## Restriction of Construction of Ships Order, 1940

THE official text of the Restriction of Construction of Ships Order, 1940, issued by the Lords Commissioners of Admiralty under the Defence Regulations, 1939, which came into force on Monday, February 1st, 1940, has now been published. The Order provides that :—No person shall construct or cause or permit to be constructed in the United Kingdom any ship otherwise than to the order of any Department of H.M. Government in the United Kingdom except under the authority of a licence granted by the Admiralty. Any licence which, at the date of coming into force of this Order, has been granted by the Board of Trade or by the Ministry of Shipping under the Restriction of Construction of Ships Order, 1939 (*b*), and is then in force, shall be deemed to be a licence granted by the Admiralty and reference in that licence to the Board of Trade or the Minister of Shipping shall be construed accordingly. Every person whose business or part of whose business is to construct ships or to produce any articles or material required for, or in connection with the construction of ships in the United Kingdom shall, upon being requested so to do by the Admiralty and within such time as the Admiralty may direct, furnish to the Admiralty such returns and other information relating to the business of that person as the Admiralty may require. In this Order the expression "ship" has the same meaning as in the Merchant Shipping Act, 1894 (*c*). A similar Order has been issued covering the repair, alteration, and dry-docking of ships.

## Armament Production Conference

IN Journal Notes last week, we referred to Mr. Churchill's call for men and women in industry, and the comments on the situation by Mr. Fred A. Smith, general secretary of the Amalgamated Engineering Union. On Monday, February 5th, the essential particulars of the Government's requirements in labour for increasing armament production were laid before the executive committee of the A.E.U. in a conference at the Ministry of Labour. Mr. Ernest Brown, Minister of Labour and National Service, was in the chair, and representatives of the Service Departments and of the Ministry of Supply were with him. Mr. J. Tanner, president of the A.E.U., and Mr. Fred A. Smith, the general secretary, led the representatives of the A.E.U. Full details of the Government's plans for new factories and a method of augmenting labour at given periods were furnished by the Government spokesmen. A survey of labour supply undertaken by the late Mr. Humbert Wolfe as his last task at the Ministry showed that the relaxation of customs agreements, or "dilution," agreed to by the engineering trades unions, were not enough to meet the Government's requirements. These agreements, said Mr. Brown, were intended to meet pre-war defence requirements. The expansion and momentum of production were daily increasing, and it was hoped that the peak would be reached some time next year. To achieve this aim, the rationing of skilled labour must replace haphazard distribution. After the meeting, Mr. Fred Smith said that the programme outlined was the most ambitious imaginable, and a vast labour force would be necessary. The executive of the A.E.U. has given an undertaking to do everything possible to assist the Government. The A.E.U. expects to be able to give its considered reply to the Minister of Labour in about ten days' time. Meanwhile, the Minister will meet the Confederation of Engineering and Shipbuilding Unions on February 13th for similar talks. At this conference the question of the introduction of women into the engineering industries will be brought up.

## The Employment Returns

IT is announced by the Secretary to the Ministry of Labour and National Service that on January 15th, the number of unemployed persons on the registers of employment exchanges in Great Britain were 1,219,503 wholly unemployed, 249,723 temporarily stopped, and 49,670 normally in casual employment, making a total of 1,518,896. This was 157,371 more than at December 11th, 1939, but of this increase more than 140,000 were accounted for by the industries most liable to be adversely affected by frost and snow. On the day of the count, bad weather made work in the open impossible over a wide area and large groups of workers were temporarily "stood off." The total counted as unemployed, namely, 1,518,896, was 520,130 fewer than twelve months ago. Building showed an increase, as compared with a month ago, of 101,571, agriculture 16,014, public works contracting 13,084. On the other hand there were considerable reductions in many industries, chiefly coalmining, reduction of 11,167, cotton 2269, and motor vehicles, cycles, and aircraft, 1625.

## Merchant Shipbuilding and Repairs

SPEAKING in the House of Commons on Wednesday, January 31st, the Prime Minister announced that H.M. Government had decided that the Admiralty shall become responsible for merchant shipbuilding and repairs as from Thursday, February 1st, 1940. The arrangement adopted was similar to that, he said, which was adopted in the latter part of the war of 1914–18. It was sought to secure from this change in organisation the advantages of centralising the use of all the resources available for shipbuilding, both in materials and labour, and of introducing greater elasticity into the allotments of capacity to naval and mercantile requirements. The Admiralty, Mr. Chamberlain stated, will assume the responsibility for ensuring the necessary production of mercantile shipping, as well as that of meeting the requirements of the Navy, it being understood that, as regards the types of merchant ships to be built, the Admiralty will meet the requirements of the Ministry of Shipping after consultation with representatives of shipowners. Sir James Lithgow, Bt., Mr. Chamberlain announced, has been appointed to the Board of Admiralty as Controller of Merchant Shipbuilding and Repairs, and Sir Amos Ayre, who is at present Director of the Merchant Shipbuilding and Repairs Division of the Ministry of Shipping, has become Director of Merchant Shipbuilding and Repairs at the Admiralty. In answer to a question, Mr. Chamberlain added that the Admiralty would be responsible for the building of the ships, and that the ships when built would be the property of the Government. In reply to further questions, as to Sir James Lithgow's appointment, Mr. Chamberlain stated that he was considered by the Government to be the most fitting and best qualified for the position to which he has been appointed. It is understood that Sir James will serve without salary. Few men have such a close relation with the shipbuilding, steel, and engineering industries, particularly those of West Scotland. Sir James is the chairman of Lithgows, Ltd., William Hamilton, Ltd., William Beardmore and Co., Ltd., David Rowan and Co., Ltd., the Steel Company of Scotland, Ltd., and National Shipbuilders Security, Ltd., and he is a director of Colvilles, Ltd., the Ayrshire Dockyard Co., Ltd., James Dunlop and Co., Ltd., Nimmo and Dunlop, Ltd., and other firms, including the Scottish Advisory Board of Credit for Industry, Ltd.

E

# Remote Supervisory Control on the Wirral Railway

No. II

(*Continued from page 104, Feb. 2nd*)

BY means of the Strowger remote photo-telemetering equipment on the Wirral railway electrification scheme, any of several meter readings may be selected at the sub-stations, and continuously indicated at the control room. These readings are: (*a*) total D.C. current from the rectifier; (*b*) bus-bar voltage; (*c*) voltage of any track feeder. Current and voltage readings are indicated on separate instruments mounted at the top of each sub-station panel on the control room switchboard. By depressing the particular push-button on the control switchboard the selective metering operation is initiated. When the selective operation has been completed by the automatic equipment, the H.T. supplies are automatically switched on to the valve anodes of the metering equipment at both the control room and the sub-station. In the event of the particular selection being a voltage indication, the appropriate interposing relay is also actuated to energise the voltage photo-telemetering meter from the desired source.

The basic principle of the A.T.M. photo-telemetering system depends upon the fact that the ordinary permanent magnet type of moving coil instrument indicates the average current in a circuit. Suppose for example that the current in a steady D.C. circuit is adjusted so that a moving coil instrument in series with it indicates 100. Also suppose that the same current is steadily interrupted and re-established so that the duration of the zero current periods is exactly equal to the periods during which the current flows. In this case, the instrument will indicate only 50, *i.e.*, it will show the impulse ratio. If suitably damped

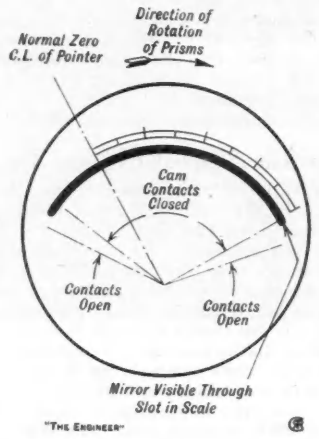



FIG. 9—TRANSMITTING INSTRUMENT

for the particular speed of impulsing the instrument will accurately indicate the changes in impulse ratio from zero to 100 per cent. The photo-telemetering transmitter sends out impulses which automatically vary in ratio according to the displacement of the pointer of the transmitting instrument. After amplification and rectification at the receiving end, the impulses are passed to a constant potential circuit containing a moving coil instrument scaled to match the transmitting instrument. In the case of the photo-telemeters on the Wirral scheme impulse ratios of 25 per cent. and 95 per cent. correspond to zero and full-scale readings respectively. Hence, with this particular arrangement, the pointer of the receiving instrument falls below zero by mechanical bias when a reading is not being taken, this method presenting the advantage that inherent sources of error at the lower readings are reduced to negligible proportions.

As the pilot wires are in the form of overhead lines quite high frequency currents can be transmitted without undue loss. Voice frequency currents of 3000, 4000, and 5000 cycles per second, are employed for photo-telemetering, thus permitting a telephone conversation to be conducted at the same time as metering indications. Moreover, since the pilot lines are used in two branches, a meter selection can be set up with each remote sub-station, each of the three sub-stations on one branch using one of the three different frequencies and the two sub-stations on the other branch using two of the frequencies. At the receiving end, frequency separating circuits divert the incoming metering impulses to their respective receiving instruments.

The photo-telemetering equipment at each sub-station comprises two separate transmitter units, one for voltage, and one for current readings. Each transmitter unit consists of a meter and an impulse generator. There is also a valve oscillator common to both transmitting units. A common power supply equipment provides A.C. for the indirectly heated filaments and D.C. for the grid bias and anode circuits, the whole operating from transformers and metal rectifiers fed from the 230 volts sub-station supply.

The transmitting meters are standard moving coil instruments having special scales as shown in Fig. 9, and only 90 deg. of the full 120 deg. scale are calibrated. On a slightly smaller radius than the calibrated portion of the scale there is a slot behind which is a thin glass mirror, the arrangement being similar to the anti-parallax reflectors on precision instruments. The pointer is about $\frac{3}{32}$in. wide.

The meter is mounted so that the scale is visible through an aperture cut away for scanning purposes, the arc of mirror being concentric with a system of rotating lens prisms on the impulse generator. The object of the latter is to control by optical means the ratio of the A.C. impulses corresponding to the deflection of the meter's pointer. The impulse generator includes a small synchronous motor which by means of a reduction gear box, rotates at 90 r.p.m. a carriage having three arms on each of which is mounted a lens prism. The carriage also has a cam which, as shown in Fig. 9, closes contacts as each rotating lens prism reaches a predetermined point when approaching the mirror, and opens them again after fully sweeping the mirror. The impulse generator also contains an under-run 36 watt lamp, and a photo-electric cell together with its amplifying valve.

A schematic diagram showing the optical arrangement is given in Fig. 10. Each lens-prism is so adjusted, that the image of the lamp filament is so small as to be completely interrupted by the meter pointer when passing during scanning. When the light beam is uninterrupted, it is totally reflected by the mirror on to the photo-electric cell as shown in Fig. 10A, whereas when the light is interrupted by the pointer as indicated in Fig. 10B, the photo-electric cell is darkened, and this causes its impedance to be increased considerably.

As the light beam from each lens-prism traverses the mirror it will be interrupted at a point dependent upon the meter reading at the time. Since the voice-frequency signal current transmitted to the line begins immediately the cam springs open and ceases when the light image is interrupted by the pointer, the ratio of the transmitted impulse will vary with the meter readings.

The circuit arrangements of the sub-station voltmeter impulse generator and the transmitter are shown in Fig. 11. Upon a metering selection being established, relay MV operates and connects the impulse generator to the transmitter. In the case of ammeter readings the points switched by the relay MV would be under the control of another relay MA (not shown in the diagram), and these would be connected to the ammeter impulse generator. To prevent the relays MV and MA

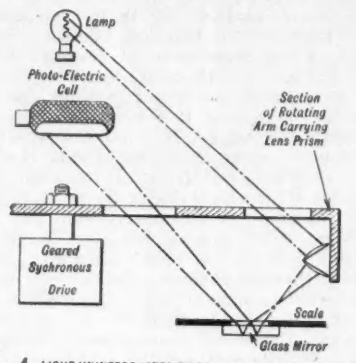

Lamp
Photo-Electric Cell
Section of Rotating Arm Carrying Lens Prism
Geared Synchronous Drive
Scale
Glass Mirror
A. LIGHT UNINTERRUPTED BY POINTER & PHOTO-ELECTRIC CELL ILLUMINATED.
Meter Pointer Interrupting Beam of Light
B. LIGHT OBSTRUCTED BY POINTER & DARKENING THE PHOTO-ELECTRIC CELL.
"THE ENGINEER"

FIG. 10—OPTICAL ARRANGEMENTS

operating together an electrical interlocking feature is provided. The operation of relay MV switches HT on to the transmitter, prepares a circuit for the cam springs and completes the anode circuits of the MH41 valve and photo-electric cell. By the interruption of the light beam by the instrument pointer the impedance of the cell is increased. This causes a slight negative potential to be applied to the grid of the valve MH41 and the anode current then decreases.

This change of anode current flowing through one winding of the transformer T1, induces an impulse on to the grid of the thyratron BT8, this impulse being repeated each time the light beam is interrupted, *i.e.*, four and a half times per second. The thyratron is a mercury-filled triode and has the characteristics that as long as the grid remains at negative potential, anode current can be prevented from flowing. But once ionisation of the mercury vapour has occurred, either by increasing the HT above the critical value or by removing the negative grid bias, the grid with normal voltages loses all control over the anode current which is then only limited by the external resistance and

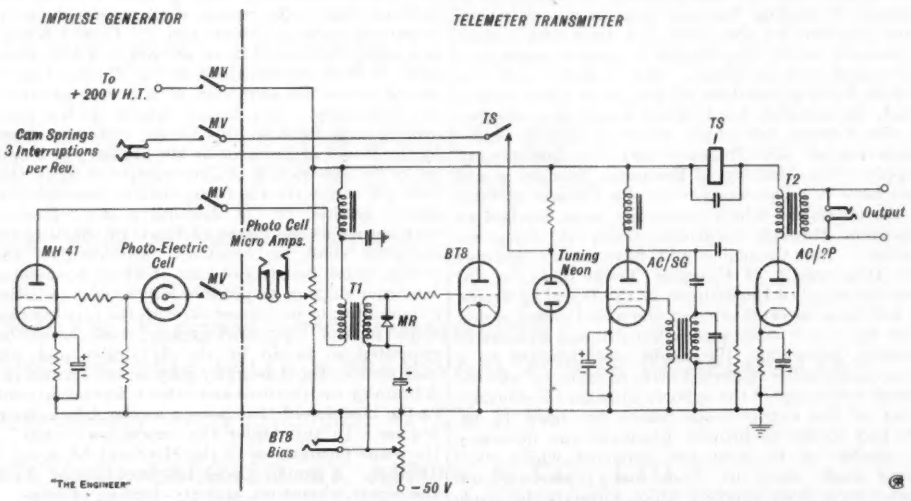



FIG. 11—CIRCUIT OF SUB-STATION VOLTMETER IMPULSE GENERATOR AND THE TRANSMITTER

a voltage drop between the anode and cathodes of about 15 volts. The metal rectifier MR prevents the thyratron from being de-ionised after striking, as a result of the large negative impulse opposite to the striking impulse produced when the anode current in MH41 is restored to normal. The voice frequency current is generated by a screened grid valve oscillator AC/SG and is fed to an output amplifier before being passed to the line.

For the oscillator valve the screen potential is provided by a potential divider which consists of a resistance and a three electrode neon tube connected in series with the H.T. supply. The purpose of this resistance is to control the current through the neon tube or the thyratron. The centre electrode of the neon tube is directly connected to the screen grid of the AC/SG valve, and when the tube is glowing it is at about 70 volts positive potential, this pressure being used to control the duration of the voice frequency line signals. During the time that the ammeter reading is being taken relay TS remains operated. When the cam springs close shortly after the commencement of each impulse the BT8 thyratron anode becomes connected in parallel with the neon tube, but since the thyratron grid is at negative potential and is not ionised it does not draw current and leaves a potential of about 140 volts across the neon tube.

When a positive impulse is transmitted by the grid of the thyratron, as a result of the light beam being interrupted by the meter pointer, it ionises instantaneously and passes current. The voltage between the anode and cathode falling to about 15 volts virtually short circuits the neon tube since it cannot remain glowing at much less than 140 volts. Hence the neon tube de-ionises and removes the positive potential from the screen grid of the AC/SG valve, which suppresses the oscillations, and removes the voice frequency impulse from the line.

The Thyratron remains ionised until the light beam has traversed the remainder of the meter scale, whereupon the cam springs open for about 30 milli-seconds, to interrupt the anode circuit. This brief period is ample to enable the grid to regain control before the next impulse. Opening the cam springs thus extinguishes the thyratron, and removes the short circuit from the neon tube. This tube therefore "strikes" again, and restores the positive potential to the screen grid of the oscillator valve, thus permitting the next impulse to commence.

Whilst the three valves have automatic bias, the bias of the thyratron is adjustable by means of a potentiometer between zero and 45 volts, facilities being provided for measuring the bias potential of the thyratron, and also the photo cell current which is controllable by means of a potentiometer and varies between 1·0 and 0·2 micro-amperes, when illuminated and darkened respectively, although the figures vary with individual cells. As premature application of the HT supply to the thyratron before its filament has had time to heat up, might possibly damage the coating of emitting material of the filament, a delayed HT switching operation is provided by the relay TS. which does not operate until the cathode of the valve AC/2P has commenced emission. As the thyratron requires about the same length of time in which to heat up, the thyratron can be effectively protected by means of the relay.

Five photo telemeter receivers are provided at the control room, one for each remote sub-station, together with five pairs of moving coil instruments, one for voltage readings, and one for current readings in each case. A common power supply derived from the 230 volt station supply serves the whole of the metering receiving equipment.

Receiving circuit arrangements are shown in Fig. 12. Upon the completion of a metering selection relay TV operates and connects the appropriate moving coil instrument to its receiving circuit. In the event of ammeter readings being required a relay TA (not shown in the diagram) would operate instead of TV. The incoming impulses are filtered out, and passed to an input control potentiometer, thence to the grid of valve V1. This valve and valve V2 are simple amplifiers and the output of V2 is stepped by means of transformer T3 to feed the three-electrode neon tube *via* two current limiting resistances. The third electrode of the neon tube is connected *via* resistances to the grid of valve V3, and also to earth. The purpose of the neon tube is to ensure a sharp start, and a sharp cut off of each impulse by eliminating the adverse effects of any extraneous line noise currents.

The centre point of transformer T3 is connected to a potential slightly below the normal ionising voltage of the neon tube by means of a potential divider across the H.T. supply. Another potential divider is employed to bias the output valve V3, the cathode of which is raised to about 30 volts positive to reduce the residual anode current in the meter to zero.

Owing to the amplified voice frequency being superimposed on the steady D.C. potential, when the line impulses are received, the neon tube becomes ionised, which lowers the impedance of the tube from almost infinity to a relatively low value, thus completing a circuit from the point of view of positive potential on the centre tap of transformer T3, both transformer windings and their resistances in parallel, the neon gas of the tube and the six megohms leak to earth. The flow of current over this circuit swings the grid of the valve V3 to a high positive value with a trigger like action and anode current is thus caused to flow in the meter, but immediately the line impulses cease, the grid of the valve returns to its normal zero potential, and stops the flow of anode current.

The impedance of the neon tubes changes somewhat with the strength of the incoming signal, and tends to be reduced as the signal strength increases. Corresponding changes therefore occur in the amount of grid swing on valve V3, the impedance of which is also affected. But this inherent source of error is reduced to negligible proportions by incorporating in the circuit an external series resistance of very high value in comparison with the impedance of the valve. As the maximum current through the meter does not exceed 0·5 milliamperes, the total resistance of the meter circuit is 400,000 ohms. Another possible source of inaccuracy is the variation in voltage of the H.T. supply. But errors attributable to this cause are eliminated by a Stabilivolt glow discharge tube, which maintains the H.T. supply constant over a wide range of output voltages and output loads.

Meters have an adjustable mechanical bias to absorb that portion of the impulses corresponding to the zero reading. A "deflect" meter key is also provided for adjustment purposes, and when actuated, shunts the neon tube by a resistance which stimulates its ionised impedance, and enables the calibrating resistance to be set for full-scale reading, the two adjustments being made during final calibration tests on site.

To eliminate oscillations of the pointers, the moving coil receiving meters are heavily damped, both mechanically and electrically, the electrical damping being accomplished by an electrolytic condenser of high capacity connected across the meter terminals.

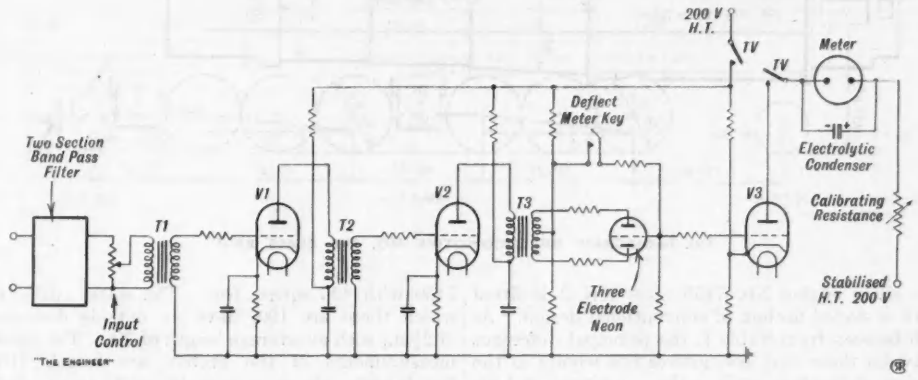



FIG. 12—RECEIVING CIRCUIT

# Large American Mallet Locomotives

By HOWARD COBLE

No. I

IN the following article the work of some recent high-powered four-cylinder simple Mallet articulated locomotives of the 2–6–6–2, 4–6–6–4, and 4–8–8–2 types in service on three of the leading United States railroads is dealt with. In recent years the multiplication of dynamometer tests has brought into prominence the measurement of locomotive capacity in terms of horsepower rather then by the rated tractive power method of comparison. The limitations of the tractive force formula are, of course, well known, and it is recognised that accurate horsepower figures can be arrived at only as the result of experiment in road service. The total horsepower developed by the locomotive being calculated from indicator cards taken direct from the cylinders, and the drawbar horsepower, or net power available for moving the train, from a continuous dynamometer car record of the pull on the tender drawbar. The records of dynamometer tests here given should, therefore, prove of exceptional interest.

The engines dealt with are listed in Table I. They are amongst the largest and most powerful steam units so far built.

### BALTIMORE AND OHIO CLASS RAILROADS "KK–1 AND KK–2 LOCOMOTIVES

Toward the end of the year 1930 the Baltimore and Ohio Railroad (B. & O.) introduced for fast freight and heavy passenger service two very powerful four-cylinder Mallet articulated locomotives, having the 2–6–6–2 wheel classification. Built by the Baldwin Locomotive Works of Philadelphia, to the requirements of Colonel

TABLE I.—*American Articulated Locomotives*

| Railroad | B. and O. | | N.P. | S.P. | |
|---|---|---|---|---|---|
| Type | 2–6–6–2 | 2–6–6–2 | 4–6–6–4 | 4–8–8–2 | 4–8–8–2 |
| Class | KK–1 | KK–2 | 2–6 | AC–7 | AC–4 |
| Date | 1930 | 1930 | 1936–37 | 1937–38 | 1929 |
| Cylinders, diameters stroke, in. | 23 × 30 | 23 × 30 | 23 × 32 | 24 × 32 | 24 × 32 |
| Driving wheels diameter, in. | 70 | 70 | 69 | 63 | 63 |
| Boiler working pressure, lb. | 250 | 250 | 250 | 250 | 235 |
| Rated tractive power, lb. | 90,000 | 90,000 | 104,500 | 124,300 | 116,900 |
| Heating surfaces, square feet :— | | | | | |
| Tubes and flues | 5677 | 5975 | 4993 | 5992 | 5992 |
| Combust. cham. thermic syphons | None | | 213 | | |
| Firebox total | 865 | 496 | 839 | 513 | 513 |
| Total evaporative | 6543 | 6471 | 5838 | 6505 | 6505 |
| Superheater | 1666 | 2900 | 2114 | 2988 | 2988 |
| Combined | 8209 | 9371 | 7946 | 9493 | 9493 |
| Grate area, square feet | 92 | 92 | 152·3 | 139 | 139 |
| Weights, tons :— | | | | | |
| On leading truck | 13·3 | 13·3 | 32·5 | 34·0 | 38·8 |
| On drivers | 166·0 | 166·5 | 194·1 | 234·2 | 212·1 |
| On trailing truck | 28·1 | 28·1 | 52·0 | 21·7 | 23·3 |
| Engine total | 207·4 | 207·9 | 278·6 | 289·9 | 274·2 |
| Locomotive | 329·2 | 329·7 | 463·9 | 463·5 | 447·8 |
| Superheater type | "A" | "E" | "A" | "E" | "E" |

G. H. Emerson, the B. & O.'s Chief of Motive Power and Equipment, these locomotives—No. 7400 class KK–1, and No. 7450 class KK–2—were in a sense experimental, being specially worked out to comply with severe weight and clearance limitations, whilst, at the same time, developing high power for operation in heavy freight and passenger service. The first of the two locomotives to be completed, No. 7400 class KK–1, is of special interest, in being equipped with a water tube firebox of a type developed on the railroad, whilst

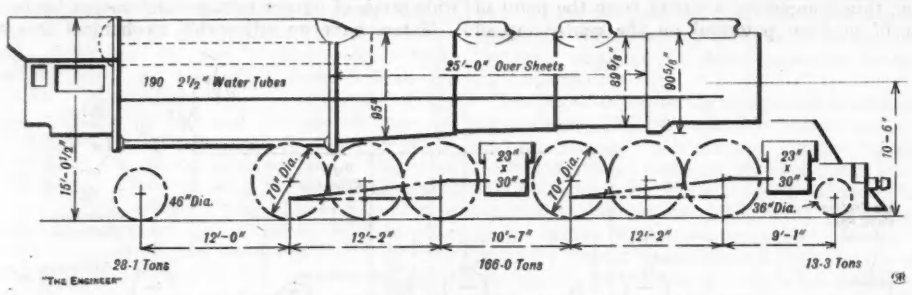



FIG. 1—DIAGRAM OF LOCOMOTIVE NO. 7400 CLASS KK-1

the sister engine No. 7450 class KK–2 is fitted with a stayed firebox of conventional design. As will be seen from Table I, the principal difference between these two locomotives lies wholly in the design of the boiler, since the machinery of both is identical. Owing to the fact that excellent service had been obtained from the Emmerson water tube firebox, No. 7400 was given this feature of design together with a type "A" superheater and a Seller's type B.F. exhaust

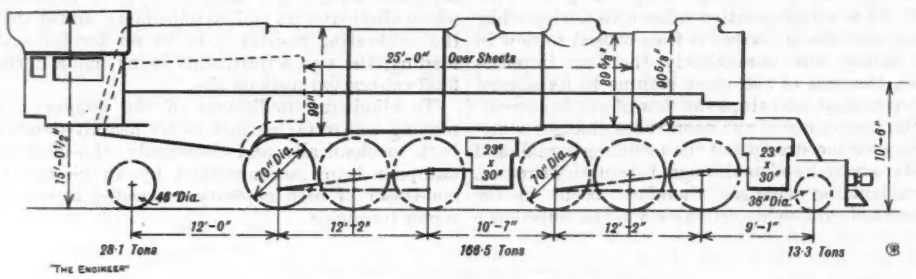



FIG. 2—DIAGRAM OF LOCOMOTIVE NO. 7450 CLASS KK-2

feed water heater injector, whilst No. 7450, with its conventional stayed firebox fitted and two Nicholson thermic syphons, had a type "E" superheater of large size, and the same injector as No. 7400.

### LOCOMOTIVE NO. 7400 CLASS KK–1

The boiler of No. 7400 (Fig. 1) is of the inverted wagon top type, with an outside diameter at the first ring of 89½in., and having a working pressure of 250 lb. per square inch. The fire tubes number 260 with a diameter of 2¼in., whilst there are 52 5½in. diameter superheater flues. The length between tube plates is 24ft. 10⅜in. The tubes and flues furnish 5677 square feet of heating surface. The elements of the superheater are 24ft. 3in. long and 1·5in. outside diameter.

The special feature of this locomotive is the Emerson water tube firebox, in which a double row of tubes extends from a hollow mud ring at the bottom as a manifold and is connected at the top end to a header connected by cross circulating tubes to a steam drum, forming the top of the firebox. Inspection plugs in the mud rings and the header opposite the ends of the tubes give ready access for turbining and cleaning, without removing the lagging. The front of the steam drum and the rear of the water legs are connected to the shell of the boiler, circulation being established through the hollow mud ring and side wall tubes. The box gives 866 square feet of heating surface, an increase of approximately 46 per cent. over the conventional stayed firebox on locomotive 7450 with 496 square feet. The water tubes, of which there are 190, have an outside diameter of 2¼in., with an average length of 7ft. The inside measurements of the firebox are length 11ft. 6in. by 8ft., the grate area being 92 square feet. From the table of general dimensions, Table I, it will be seen that locomotives 7400 and 7450, excluding the tender, are almost the same weight, *i.e.* 207·4 and 207·9 tons, it being particularly noteworthy that the water tube firebox was applied without increasing the weight borne by the two-wheel trailer truck, or the total weight of the engine.

### LOCOMOTIVE NO. 7450 CLASS KK–2

Locomotive No. 7450 is shown in Figs. 2 and 3. The boiler is of the inverted wagon top type having a designed working pressure of 250 lb. per square inch. The diameter at the first ring is 89½in., increasing to 99in. at the firebox. The superheater flues number 224 with a diameter of 3½in., and there are 59 fire tubes of 2¼in. diameter, the length between tube plates being 24ft. 10⅜in. The type "E" superheater supplied by the Superheater Co., comprises 224 elements with a length in the flue of 24ft. 3in.; the tubes have an outside diameter of 1·2in. The radial stayed firebox provides a total heating surface including the two Nicholson thermic syphons of 496 square feet. The inside firebox measurements and grate area are the same as those of the class KK–1 locomotive, but the superheater area is much greater: 2900 as against 1666 square feet, whilst the evaporative area, see Table I, is but little smaller.

### MACHINERY DATA

The machinery of Nos. 7400 and 7450 is identical in every respect. The cylinders (four) are 23in. in diameter with a 30in. stroke, and steam distribution is effected by 12in. diameter piston valves set to give a full gear cut-off of 72 per cent. and operated by a light design of Walschaerts motion, which is controlled by a "Barco" power reversing gear. The tractive force at 85 per cent. of the working pressure is 90,000 lb.

The maximum valve travel is 7in. The driving wheels have a diameter of 70in. and are uniformly spaced at 6ft. 1in. centres in each engine unit. The main driving axle journals are 12in. by 13in., and those for the remaining coupled axles 10½in. by 13in. The locomotives are mechanically fired by a "Lower" type mechanical stoker, and the fire door is power operated.

The tender used for these "Mallets" is of the Vanderbilt design, mounted on two four-wheeled trucks, and has a capacity of 18,000 gallons of water, and 17·8 tons* of coal. The trucks have 36in. diameter wheels, with a wheel base of 6ft. 2in., and spaced 27ft. 4in. between centres. The loaded weight of the tender is 121·7 tons.

### DYNAMOMETER TEST

After a suitable "breaking in" period in slow freight service, the locomotives were subjected to a thorough road test with dynamometer car. These tests were made to obtain data on the relative performance of the engines as a whole under actual operating conditions and at the same time to obtain information on the performance and economy effected by such devices as the exhaust steam injector and the type "E" superheater. An opportunity was also presented to make a comparison between locomotive 7400 equipped with a water tube firebox, and locomotive 7450 equipped with a stayed firebox of normal design. In addition to the above information it was desired to secure data which would be comparable with that obtained on road tests of other engines in general use.

With the above object in mind the East end of the Cumberland division, between Keyser, West Virginia, and Brunswick, Maryland, was selected as the logical territory over which to conduct the test runs (for condensed profile of this division see diagram, Fig. 4. This division offers many advantages as a "testing ground," the chief of which is that numerous tests of different classes of locomotives have been made over it. Other considerations are that trains of the desired tonnage are readily obtained while the distance between terminals points some 110 miles is such that all-daylight runs are possible. The Cherry Run low grade also offers a stretch approximately 12 miles in length with a 1 in 333 compensated gradient over which the locomotives can be worked continuously, at a high rate under constant conditions, for a comparatively long period.

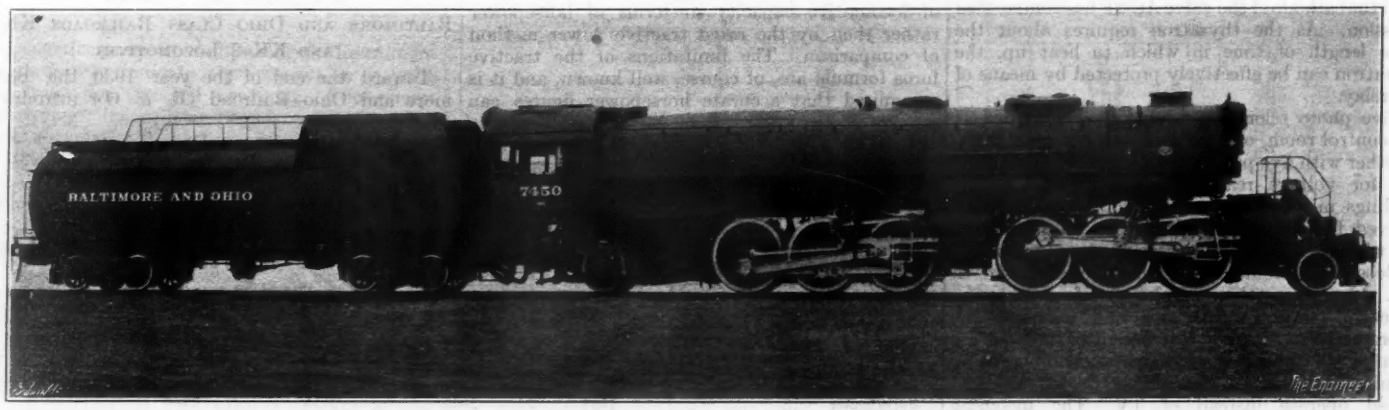



FIG. 3—BALTIMORE AND OHIO RAILROAD LOCOMOTIVE NO. 7450

The first series of tests, which was made with locomotive 7450 class KK–2, was commenced on January 12th, 1931, and completed on the 26th of that month. During this period thirteen trips were run, the first three of which were more or less preliminary, being devoted to ascertaining the correct size of exhaust nozzles to give a draught of 5·5in., and in adjusting the various auxiliaries. The total mileage run by this locomotive while

* English 2240 lb. tons are given throughout, but U.S. gallon is retained.

under test was 1420 miles. The second series of trials, made with No. 7400 of the KK–1 class, was started on January 29th, 1931, and completed on February 23rd, during which time fourteen trips totalling approximately 1525 miles were run.

The tests were carried out under conditions as near those of actual operation as was possible. Eastbound the "Mallets" worked trains made up of loaded 44·3 and 66·5 ton capacity coal cars, with enough cars in each train to make the calculated rating of 8660 adjusted tons. Westbound the locomotives hauled empty coal car trains of approximately 3258 adjusted tons. Throughout the entire series of tests the dynamometer car was placed between the tender and the train, and in all cases where it was necessary to use a banking locomotive the car was placed at the rear so that the actual pull of the road locomotive would be recorded on the chronograph chart. During these tests, in addition to the usual data, such as weight of coal fired, weight of water from tank, boiler and steam pipe pressures, regulator opening, cut-off, etc., etc., a special log of the performance of the injectors was kept, while great care was taken in measuring the temperatures of the steam. This was done so that the accurate indication of the performance of the superheaters and injectors could be made. The special injector log referred to embraced observations of exhaust steam pressure at the heater, temperature of the water leaving the exhaust steam heating tubes, and the temperature of the water entering the boiler. These observations were taken so that the quantity of water reclaimed from the exhaust steam could be determined.

For purposes of comparison two tests with No. 7400 were run westbound feeding the boiler with the live steam injector. This injector was a Seller type K N L.

The same driver was employed on all tests, while the same fireman was employed for all except one round trip with locomotive No. 7450. The coal used was obtained from the Galloway mines of the Sampson Creek Coal Co. In this way truly comparative conditions were secured, since any unusual variation in the operation and firing was eliminated.

Composite samples of the fuel used on each series of tests were analysed and the results are shown below in tabulated form :—

| Locomotive number | 7450 | 7400 |
|---|---|---|
| Moisture | ·40 | ·50 |
| Volatile | 39·05 | 38·65 |
| Fixed carbon | 51·30 | 48·30 |
| Ash | 9·25 | 12·55 |
| Total sulphur | 3·30 | ·80 |
| B.Th.U. | 13657 | 12994 |

TABLE II.—*Baltimore and Ohio Railroad. The performance of Locomotives* 7450 (*KK–2*) *and* 7400 (*KK–1*)

| | | EASTBOUND | | | WESTBOUND | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Per cent. Increase or Decrease | |
| | | | | Per cent. Increase or Decrease 7400 over 7450 | | | | 7400 over 7450 | Seller's Exh. Feed Water Heater Inj. over L.S.I. |
| 1 | Locomotive number | 7450 | 7400 | | 7450 | 7400 | 7400 | | |
| 2 | Boiler feed | Seller's Exhaust Feed Water Heater Injector | | | Seller's Exhaust Feed Water Heater Injector | | Seller's Live Steam Inj. | | |
| 3 | Superheater, type | E | A | | E | A | A | | |
| 4 | Number cars, including 930 and caboose | 99·7 | 97·3 | 2·4 d | 122·3 | 117·3 | 127·5 | 4·1 d | 8·0 d |
| 5 | Number loads, including 930 but not caboose | 98·7 | 96·3 | 2·4 d | 1·0 | 1·0 | 1·0 | 0 | 0 |
| 6 | Actual tons (English), including 930 and caboose | 7282 | 7361 | 1·1 | 2476 | 2528 | 2748 | 2·1 | 3·1 |
| 7 | Adjusted tons (English), including 930 and caboose | 8170 | 8665 | 0·6 | 3241 | 3261 | 3640 | 0·6 | 0·4 |
| 8 | Avg. speed, throttle open, m.p.h. | 20·12 | 19·93 | 0·1 d | 21·91 | 21·98 | 22·86 | 0·3 | 3·8 d |
| 9 | Avg. running speed during test, m.p.h. | 20·97 | 20·87 | 0·5 d | 22·21 | 22·19 | 22·83 | 0·1 d | 2·8 d |
| 10 | Average drawbar pull, lb. | 48,340 | 47,951 | 0·8 d | 42,036 | 42,358 | 39,552 | 0·8 | 7·1 |
| 11 | Average drawbar horsepower | 2593 | 546 | 1·8 d | 2459 | 2483 | 2412 | 1·0 | 2·9 |
| 12 | Average throttle opening, per cent. | 91·1 | 96·1 | 4·5 | 88·7 | 96·6 | 95·3 | 8·9 | 1·4 |
| 13 | Average cut-off, per cent. of stroke | 45·4 | 42·8 | 5·7 d | 43·8 | 40·2 | 35·1 | 8·2 d | 14·5 |
| | Pressure, lb. per sq. in. | | | | | | | | |
| 14 | Steam in boiler, average | 240·7 | 246·2 | 2·3 | 240·9 | 245·4 | 247·4 | 1·9 | 0·8 d |
| 15 | Steam entering valve chests, average | 200·7 | 216·3 | 7·8 | 194·0 | 211·3 | 224·6 | 8·9 | 5·9 d |
| 16 | Exhaust steam at cylinders, average for test | 4·8 | 3·7 | 22·9 d | 5·2 | 4·1 | 5·7 | 21·2 d | 28·1 d |
| 17 | Exhaust steam, E.S.I., using exhaust steam, average | 5·3 | 3·7 | 30·2 d | 6·0 | 3·7 | — | 38·3 d | — |
| | Temperature, deg. F. | | | | | | | | |
| 18 | Steam entering valve chests, average | 580·4 | 554·9 | 4·4 d | 609·7 | 563·8 | 580·5 | 7·5 d | 2·9 d |
| 19 | Superheat, steam entering valve chests | 192·2 | 160·6 | 16·4 d | 224·2 | 171·6 | 183·3 | 23·5 d | 6·4 d |
| 20 | Superheat in exhaust steam | 36·9 | 32·1 | 13·0 d | 34·6 | 24·0 | 16·7 | 30·6 d | 43·7 |
| 21 | Smokebox gases | 507·1 | 559·8 | 10·4 | 529·8 | 556·4 | 561·1 | 5·0 | 5·6 d |
| 22 | Water entering boiler | 268·4 | 280·2 | 4·4 | 267·3 | 281·7 | — | 5·4 | — |
| 23 | Draught in smokebox, ahead diaph. inches water | 7·8 | 6·0 | 23·1 d | 8·4 | 6·3 | 6·95 | 25·0 d | 9·4 d |
| 24 | Draught in smokebox, back diaph. inches water | 6·7 | 4·7 | 29·9 d | 7·2 | 4·9 | 5·4 | 31·9 d | 9·3 d |
| | Coal, Pounds. | | | | | | | | |
| 25 | Total used | 34,433 | 31,500 | 8·5 d | 37,000 | 35,200 | 34,500 | 4·9 d | 2·0 |
| 26 | Total used, running | 33,967 | 31,500 | 7·3 d | 36,767 | 35,000 | 34,450 | 4·8 d | 1·6 |
| 27 | Per hour, engine working | 8825·7 | 7987·5 | 9·5 d | 8272·6 | 7767·8 | 7880·7 | 6·1 d | 1·4 d |
| 28 | Per 100 ton mile | 3·88 | 3·51 | 9·5 d | 12·22 | 11·35 | 11·50 | 7·1 d | 1·3 d |
| 29 | Per 1000 lb. drawbar pull effective mile | 9·20 | 8·37 | 9·0 d | 9·05 | 8·39 | 8·73 | 7·3 d | 3·9 d |
| 30 | Per drawbar h.p. hr., engines working | 3·40 | 3·14 | 7·6 d | 3·37 | 3·13 | 3·27 | 7·1 d | 4·3 d |
| 31 | Per square foot grate area per hour, engine working | 95·93 | 86·82 | 9·5 d | 89·92 | 84·43 | 85·66 | 6·1 d | 1·4 d |
| | Water, Pounds. | | | | | | | | |
| 32 | Net from tank | 205,152 | 208,239 | 1·5 | 223,799 | 228,252 | 228,225 | 2·0 | 0 |
| 33 | Net per lb. of coal, as fired | 5·96 | 6·61 | 10·9 | 6·05 | 6·48 | 6·62 | 7·1 | 2·1 d |
| 34 | Added from exhaust steam | 17,325 | 19,409 | 12·0 | 19,424 | 22,843 | 0 | 17·6 | — |
| 35 | Actual evaporation | 221,007 | 226,698 | 2·6 | 241,855 | 250,085 | 227,565 | 3·4 | 9·9 |
| 36 | Actual evaporation per lb. of coal, as fired | 6·42 | 7·20 | 12·1 | 6·55 | 7·10 | 6·60 | 8·4 | 7·6 |
| 37 | Equivalent evaporation | 295,931 | 298,776 | 1·0 | 325,408 | 331,261 | 302,309 | 1·8 | 9·6 |
| 38 | Equivalent evaporation per lb. of coal, as fired | 8·60 | 9·49 | 10·3 | 8·81 | 9·41 | 8·77 | 6·8 | 7·3 |
| 39 | Equivalent evaporation per hour, engine working | 76,936 | 75,802 | 1·5 d | 73,105 | 73,557 | 69,170 | 0·6 | 6·3 |
| 40 | Equivalent evaporation per 100 ton mile | 33·37 | 33·33 | 0·1 d | 107·36 | 106·81 | 100·73 | 0·5 d | 6·0 |
| 41 | Equivalent evaporation per 1000 lb. drawbar pull effective mile | 79·11 | 79·39 | 0·4 | 79·78 | 78·93 | 76·50 | 1·1 d | 3·2 |
| 42 | Equivalent evaporation per drawbar h.p. hr., engine working | 29·66 | 29·77 | 0·4 | 29·92 | 29·60 | 28·68 | 1·1 d | 3·2 |
| 43 | Equivalent evaporation per square foot evaporation surface per hour | 8·21 | 9·23 | 12·4 | 7·80 | 8·96 | 8·43 | 14·9 | 6·3 |
| 44 | Efficiency of boiler, including Exhaust Steam Injector, per cent. | 61·09 | 70·84 | 16·0 | 62·60 | 70·27 | 65·45 | 12·3 | 7·4 |
| 45 | Efficiency of locomotive, per cent. | 5·47 | 6·25 | 14·3 | 5·53 | 6·26 | 5·99 | 13·2 | 4·5 |
| | Heat Transfer. | | | | | | | | |
| 46 | Across water heating surface, per cent. of total | 85·59 | 85·69 | 0·1 | 85·27 | 85·00 | 92·62 | 0·3 | 8·2 d |
| 47 | Across superheating surface, per cent. of total | 7·45 | 6·64 | 10·9 d | 7·63 | 6·85 | 7·38 | 10·2 d | 7·2 d |
| 48 | In Exhaust Steam Injector, per cent. of total | 6·96 | 7·67 | 10·2 | 7·10 | 8·15 | — | 14·8 | — |

d—denotes decrease.

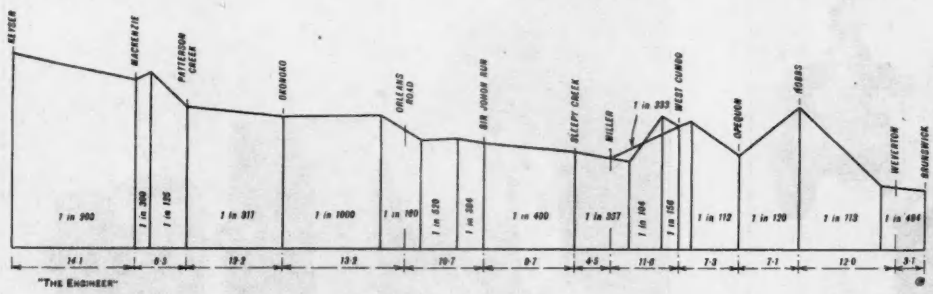



FIG. 4—PROFILE OF EAST END OF THE CUMBERLAND DIVISION

## DISCUSSION OF RESULTS OF TEST

A study of Table II, showing the test results, reveals that a direct comparison of the boiler performance of locomotives No. 7450 and No. 7400 can be made together with a comparison of the performance of the type "E" and "A" superheaters. A basis for comparison is also afforded between the Seller's exhaust feed water heater injector and the Seller's live steam injector on locomotive No. 7400 in a westbound direction. In making a comparison of the general performance of the engines the coal and water per drawbar horsepower per hour was felt to be the most accurate basis. On this basis it will be seen that in eastbound operation, using the Seller's injector, a saving in coal of 7·6 per cent. was realised by locomotive No. 7400, while in westbound operation the same engine showed a saving in coal of 7·1 per cent.

The water consumption is shown on several bases, that is net water from tank, actual total evaporation, and equivalent evaporation. The equivalent evaporation is used for purposes of

comparison since it takes into account such variables as boiler pressure, steam temperature, and superheat. The results show that on the basis of equivalent evaporation per drawbar horsepower per hour working locomotive No. 7400 uses 0·4 per cent. more water eastbound, and 1·1 per cent. less westbound, indicating that the water consumed per unit of work done was practically the same for both engines.

Equivalent evaporation per pound of coal, which gives an accurate indication of the relative boiler performance, with locomotive No. 7400 shows an increase of 10·3 per cent. eastbound and 6·8 per cent. westbound. This increase is largely due to the increase in heating surface provided by the use of the water tube firebox.

A comparison of the superheaters, based on the degrees of superheat added to the steam, shows that the type "E" superheater furnishes an increase of 31·6 degrees of superheat eastbound and 52·6 degrees westbound, and as would be expected an increase in the superheat left in the exhaust steam. This increase in superheat probably accounts for the somewhat higher indicated horsepower and tractive effort shown by locomotive No. 7450.

It was noted during the tests of locomotive No. 7400 with the Seller's live steam injector that this device had not sufficient capacity to keep the water at the proper level in the boiler while the engine was working, and for this reason the report states, there is some question as to the accuracy of the results.

However, a comparison of the performance of No. 7400 when the boiler was fed with the Seller's heater injector and its performance when fed with the live steam injector shows that, with the heater, on the drawbar horsepower hour basis, the decrease in coal consumption is 4·3 per cent. The water consumption, based on equivalent evaporation per drawbar horsepower hour, shows an increase of 3·2 per cent. when using the heater injector. It will be noted, however, that an increase of 7·3 per cent. in equivalent evaporation per pound of coal, together with an increase of 7·4 per cent. in boiler efficiency takes place when using this injector.

Under the heading "Conclusions" the Railroad's test report sums up the results obtained on the tests as follows. Based on the results recorded on these tests it may be stated :—

(1) The use of the water tube firebox will give a substantial increase in boiler efficiency and evaporation per pound of coal, both actual and equivalent, over a conventional boiler with stayed firebox and makes it possible to obtain greater economy in fuel consumption per unit of work performed.

(2) That Mallet locomotives of the type tested can be designed to meet rigid weight and clearance restrictions with sufficient boiler capacity for cylinder requirements and at the same time show increased economy over other types of modern power now in use.

(3) A higher average degree of superheat is obtained with the type "E" over the type "A" superheater, making it possible to maintain a higher sustained tractive effort throughout the working range of speed.

(4) The exhaust steam injector, through reclamation of heat and water, gives increased overall boiler efficiency, higher actual and equivalent evaporation per pound of coal, and lower fuel consumption on the drawbar horsepower hour basis than the live steam injector.

*(To be continued)*

# An Unattended Power Plant

WHEN an important industrial establishment is situated several miles from the nearest township, unattended power plant for the generation of electricity offers distinct advantages as the cost of maintaining shifts of skilled engineers is eliminated. Considerable success has been obtained with small or medium-sized power plant employing oil engines which are stopped in the event of a fault occurring and the nature of the fault is made evident.

A good example of an unattended oil engine power plant is to be found in a mining district in South Africa where W. H. Allen, Sons, and Co., Ltd., of Bedford, have installed a seven-cylinder 600 r.p.m. 266-B.H.P oil engine directly coupled to a 184 kW alternator, as shown in Fig. 5. As the set runs unattended it was deemed desirable that protection should be provided against the following contingencies: (1) alternator pedestal bearing running hot ; (2) excessive rise in temperature of alternator windings; (3) excessive rise in engine lubricating oil temperature ; (4) failure or partial failure of the flow of engine cooling water ; (5) failure or partial failure of engine lubricating oil pressure ; (6) reversal of power when running in parallel ; (7) over-voltage caused by the failure of the automatic voltage regulator ; (8) over-speed of the engine caused by faulty governing . (9) overload on the unit or under speed.

To enable the stipulated conditions to be met, an electrically operated system was developed to shut down the engine automatically in the event of any of these contingencies arising and to give a visual indication as to what fault had initiated the shut down. To take care of cases 1, 2, and 3 involving temperatures exceeding those encountered in normal running, thermostats are situated in the alternator bearing housing, in the alternator windings, and in the lubricating oil return pipe between the engine sump and the oil tank respectively : these thermostats having electrical contacts which complete a circuit on the temperature rising above pre-determined limits.

To protect the engine against cessation or reduction of flow of cooling water an adjustable "Monitor" flow meter, provided with electrical contacts, is placed in the cooling water outlet main. The rate of flow, below which it would be dangerous to run and at which the contacts close, may be pre-set to suit site conditions and the requirements of any particular cooling system. A view of the "Monitor" flow indicator placed in the engine cooling water outlet main is given in Fig. 1. In the lubricating oil main which supplies all the principal bearings with lubricating oil under pressure a "Monitor" alarm which can be set to complete an electric circuit at a pre-determined low limit of pressure is also placed (Fig. 3).

For the protection of the plant against reverse

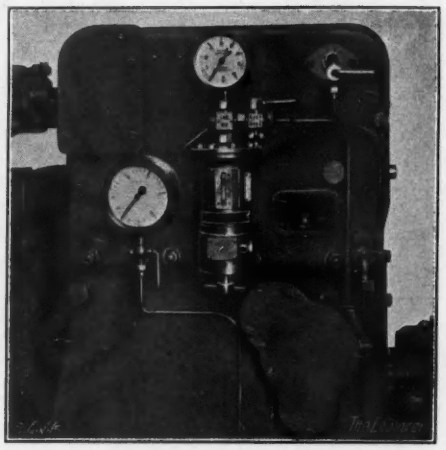


FIG. 3—"MONITOR" ALARM IN LUBRICATING OIL MAIN

power, over-volts, and electrical overload suitable electrical instruments are embodied in the alternator switchgear, the function of each being to make a contact should the safe limits be exceeded. Excessive speed or under speed are taken care of by a

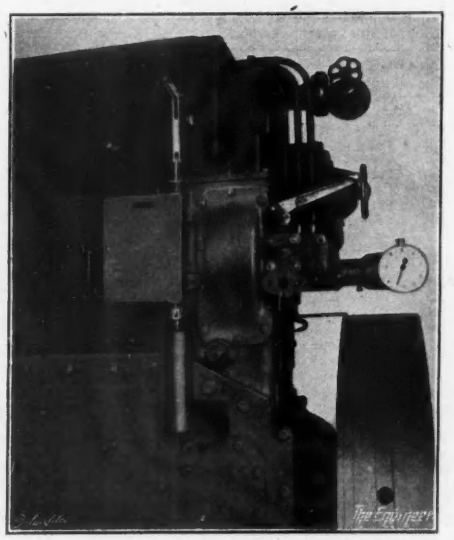


FIG. 4—"BULL PULL"

centrifugal governor switch driven from an extension of the exciter shaft as shown in Fig. 2. At the normal speed of 600 r.p.m., the governor weights run in such a position that a contact arm floats between the two contacts, representing the over speed and under speed positions, but in the event of any

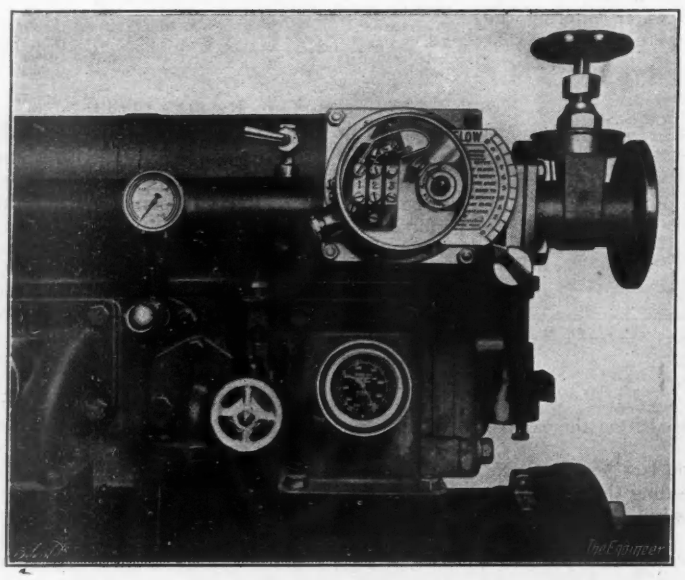


FIG. 1—"MONITOR" WATER FLOW INDICATOR

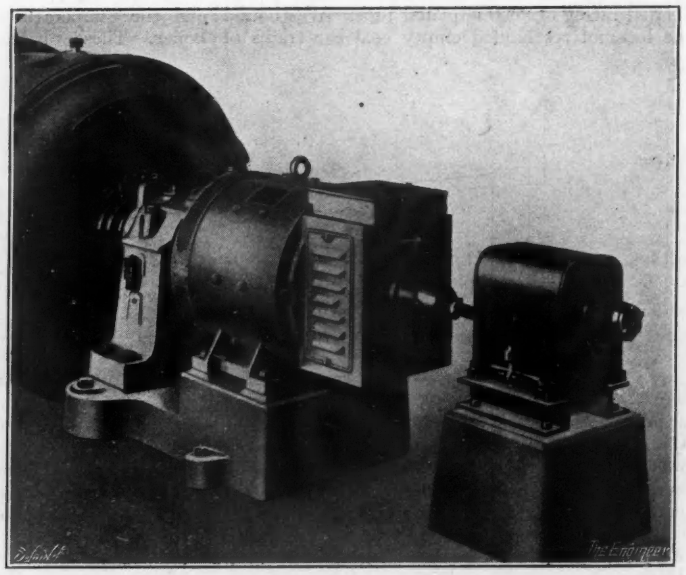


FIG. 2—CENTRIFUGAL SWITCH

abnormal increase or decrease in the speed the appropriate contact is made.

A simplified arrangement of the electrical connections is shown in Fig. 6. When an abnormal condition exists and the appropriate electrical contact is made, a circuit is completed through a drop relay on the alarm panel and a tripping relay embodied in the alternator circuit breaker. The drop relays control red lamps carried on the alarm panel, an inscription being provided against each warning lamp to indicate in which circuit the fault has occurred.

Current for the alarm devices and the red lamps is supplied from a 24-volt accumulator. When the tripping relay comes into operation, the main circuit breaker is tripped, this taking the alternator off the bus-bars and at the same time the current to the alarm device is interrupted. An additional contact on the main circuit breaker is used to energise the engine shut down relay circuit.

A proprietary device known as a "Bull Pull" is attached to the fuel cut off lever on the engine, as shown in Fig. 4. When the fuel cut off lever is placed in the running position, a heavy weight beneath the "Bull Pull" is raised and a latch inside the device holds the control in this position. But when the circuit breaker is released by the tripping relay, the additional contact energises an electromagnet in the "Bull Pull," thus releasing the weight which acts on the fuel cut off lever and shutting the engine down. After operation the "Bull Pull" breaks its own circuit. Whichever of the nine failures or partial failures occur, the sequence of events is as follows: (1) the appropriate red lamp is switched on through the operation of the associated drop relay; (2) the tripping relay is energised and the main circuit breaker opened, and (3) the engine is shut down.

A warning is given to the engine attendant by the provision of a relay which is held closed by the alternator exciter voltage. Immediately the exciter ceases to generate, the relay arm is released, and a contact is made in the battery circuit which causes an electric horn to be sounded. To enable the plant to be started up normally, a tumbler switch is used to make the safeguarding circuit operative, but when the plant is running the switch is placed in the safeguarding position.

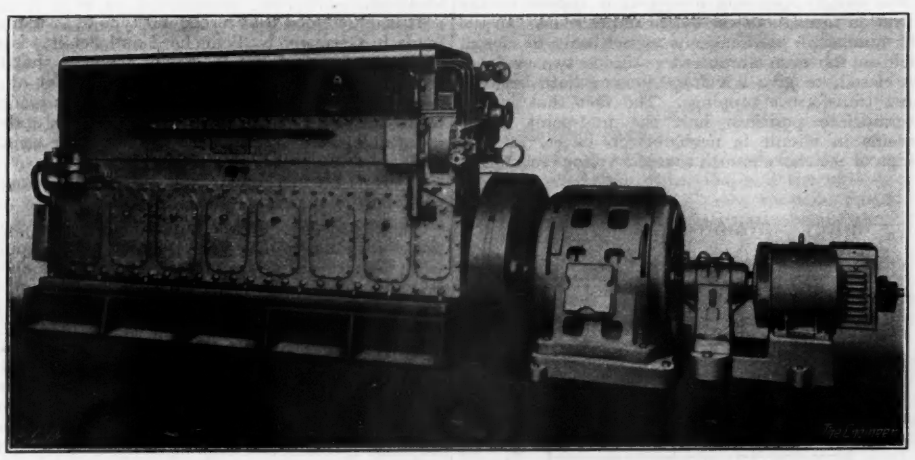


FIG. 5—UNATTENDED OIL ENGINE POWER PLANT

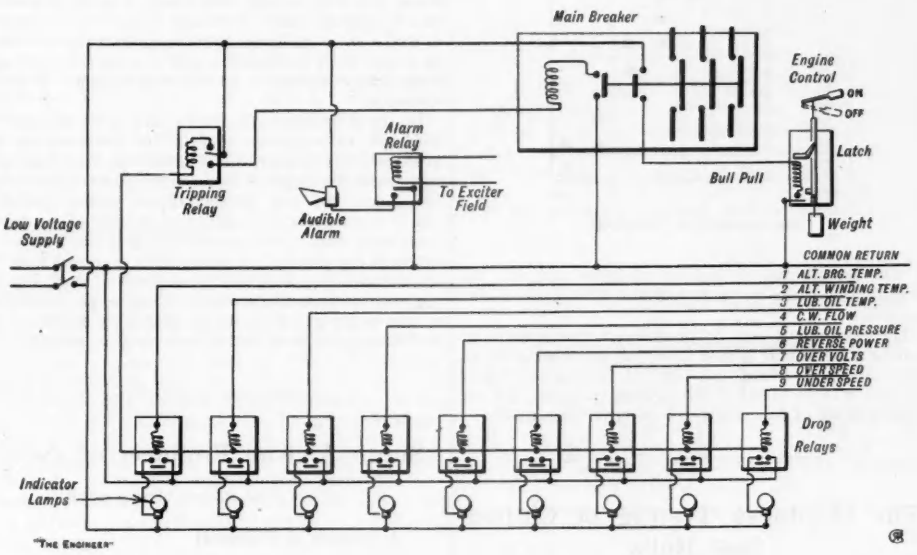



FIG. 6—ELECTRICAL CONNECTIONS OF UNATTENDED POWER PLANT

## Mercury Switch On-Load Tap-Changing Equipment

ON the smaller sizes of distribution transformers mercury switch tap-changing equipment has acquired considerable popularity in recent years. The advantages of this equipment are absence of open sparking with consequent reduced maintenance and oil contamination, and simple and compact construction. The cost is in keeping with that of the smaller transformers to which the equipment is offered.

A new mercury switch on-load tap changer, introduced by the Hackbridge Electric Construction Company of Walton-on-Thames, employs a patented method of oleomatic operation, claimed to be far superior as regards smooth and quiet working than that of a purely mechanical drive. Normally the equipment, including the driving mechanism, is mounted on top of the transformer and immersed in its tank, an arrangement made possible by the absence of any open arcing during operation. The arrangement also leads to a considerable reduction in the overall plan dimensions, which is naturally desirable where space is limited.

The equipment utilises the simple and well tried mid-point choke circuit for the operation of tap changing on load, and as the chokes are continuously rated, the mid-point provides an intermediate tapping position between each pair of transformer taps. The standard equipment has eight switches per phase and provides fifteen or any lower number of operating voltages. The mercury switches are fitted to cam operated socket arms mounted on vertical bakelite boards, which are supported and correctly spaced by distance pieces on three horizontal steel rods located at each end in cast frames. There are two boards per phase, each having a maximum of four switches and arranged back to back with the switches on the outside and the operating cams in the intervening space between the boards.

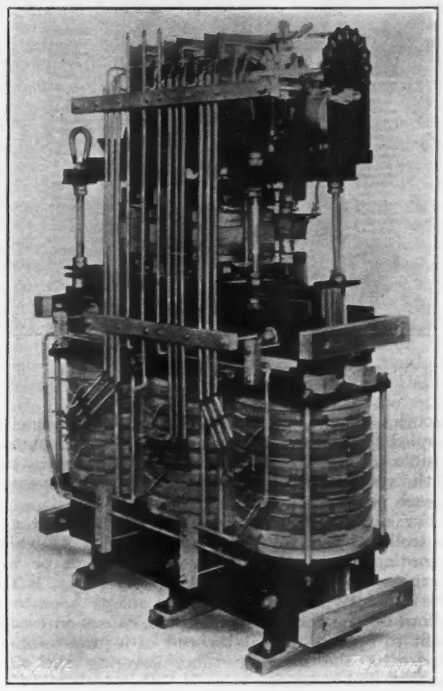


FIG. 2—500 kVA 6300/400 V. TRANSFORMER

A common square insulated cam shaft passes through the vertical boards and carries the operating cams. This shaft runs in ball bearings in the cast end frames and is coupled to the operating mechanism through a self-aligning coupling. This assembly is illustrated in Fig. 1. The compact mounting of the tapping switch mechanism together with the mid-point chokes (one per phase) above the transformer is shown in Fig. 2. To meet the very remote possibility of one of the mercury switches being damaged and allowing mercury to reach the transformer an elephantide tray is fitted underneath the complete assembly.

A power storage feature in the driving mechanism makes the tap change operation entirely free of

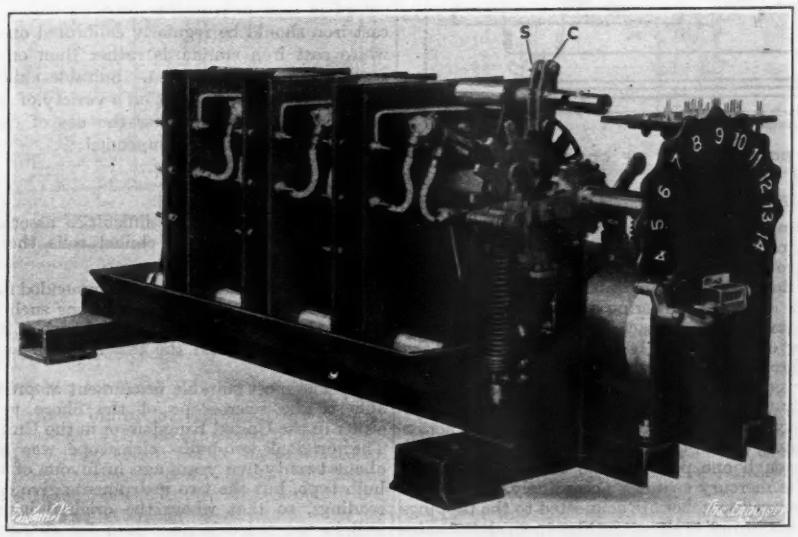



FIG. 1—MERCURY SWITCHES AND DRIVING MECHANISM

the driving motor, and the tap change cannot stop in a midway position through failure of the auxiliary supply or other cause. The power storage gear (shown in Fig. 3) comprises a rotary gear pump which pumps oil in a closed circuit into either of two cylinders or through an internal bypass. In these cylinders are pistons P, each of which operates a beam and pawl (LB and LP or RB and RP respectively) against the tension of vertical springs. During the upward stroke the pawls ride over the ratchet wheel RW, but at the end of the stroke the pawl engages and, directly the motor ceases pumping, the beam is drawn down by the spring and the pawl attached to the beam causes the ratchet wheel to turn through one position. During this motion the piston acts as a damping medium so that the movement is extremely

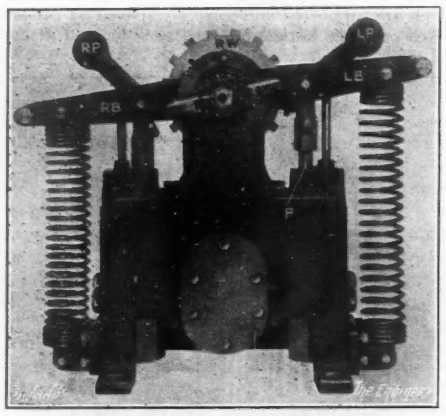



FIG. 3—POWER STORAGE MECHANISM

smooth, steady and quiet. The ratchet wheel is coupled to the camshaft and a spring loaded plunger (visible in Fig. 1) engaging on the underneath side of the ratchet wheel serves to locate the movement in each position.

For automatic operation the driving motor is controlled by a voltage relay VR (Fig. 4) which, according to whether the volts are high or low, energises the interposing relays L.T.L. or R.T.L. The mercury switch interposing relays operate as follows:—The coil, being energised, causes an escapement to operate and at the end of a predetermined time tilts the mercury tube, covering the three contacts and energising relay M.C.R., which according to whether it is energised from L.T.L. or R.T.L.

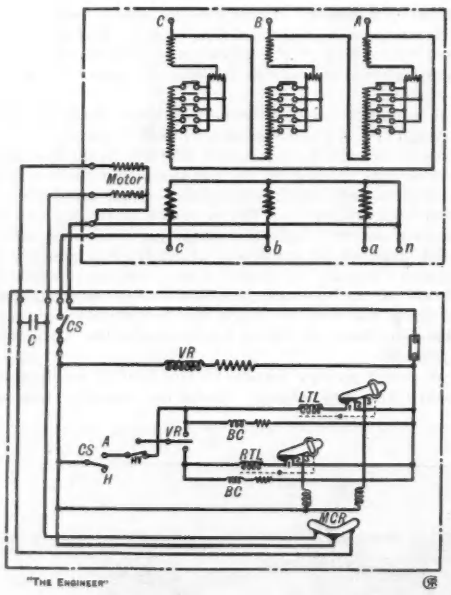


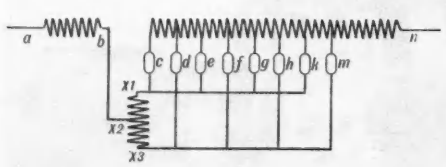

FIG. 4—DIAGRAM OF CONNECTIONS

energises the driving motor, causing it to run in a clockwise or anti-clockwise direction.

The interposing relay, remaining energised from the voltage relay, holds the mercury tube tilted and mercury flows through an orifice in the end of the tube into a pocket, lowering the mercury level in the tube until No. 3 contact becomes uncovered and the motor circuit is thus broken. Shortly after, the mercury breaks contact between 1 and 2, de-energising the relay coil circuit and the tube resets. Directly the supply to the driving motor is broken, the power storage mechanism, controlled by the damping action of the piston, causes the mercury switch cam shaft to rotate through one position, the cams on the shaft setting the mercury switches accordingly.

The mercury switches are connected to the tappings on the transformer as shown in Fig. 5, which indicates the switch position for minimum L.T. voltage (*i.e.* maximum H.T. winding), switch *c* being closed and the others open. The first movement of the driving mechanism closes switch *d*, the cam on the driving shaft rocking the switch into the horizontal position so that the mercury bridges the two contacts in the tube. Thus both switches *c* and *d* are closed on to the outer ends of the mid-point reactor, giving the effect of an intermediate tapping between the tappings *c* and *d*. A further operation in the same direction tilts switch *c* to open its contacts, leaving the equipment operating on *d* tapping, the construction of the mercury switches being such that an amply rapid make and break is provided.

The switch operation described is typical of the operation throughout the entire 15 positions. In the odd numbered positions one switch only is closed, while in the even numbered positions two switches are closed, to give a voltage intermediate between these transformer tappings. The fact that in the intermediate positions half the mid-point choke remains in circuit is negligible in effect, for the design of the choke is such that the voltage regulation




| Position Number | ● Indicates Switch Closed | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | c | d | e | f | g | h | k | m |
| 1 | ● | | | | | | | |
| 2 | ● | ● | | | | | | |
| 3 | | ● | | | | | | |
| 4 | | ● | ● | | | | | |
| 5 | | | ● | | | | | |
| 6 | | | ● | ● | | | | |
| 7 | | | | ● | | | | |
| 8 | | | | ● | ● | | | |
| 9 | | | | | ● | | | |
| 10 | | | | | ● | ● | | |
| 11 | | | | | | ● | | |
| 12 | | | | | | ● | ● | |
| 13 | | | | | | | ● | |
| 14 | | | | | | | ● | ● |
| 15 | | | | | | | | ● |

"THE ENGINEER"

FIG. 5—SWITCH DIAGRAM

of the transformer is not appreciably altered, the drop in the choke being in quadrature with the load current.

The equipment can be provided for automatic or remote control and is also fitted as standard with an external hand wheel for manual operation. Clear indication is provided of the tapping position and the total number of tap changes that have been made.

## The Hardness Testing of Chilled Cast Rolls

VARIOUS difficulties arising from time to time in ascertaining the hardness of chilled rolls have engaged the attention of the White and Chilled Iron Sub-Committee of the British Cast Iron Research Association. As a result a recommended method, given below, of taking these tests has been drawn up by the Sub-Committee. The Sub-Committee considers that instruments used on chilled or white cast iron should be regularly calibrated on chilled or white cast iron standards rather than on the steel standards usually supplied. Suitable chilled blocks are being prepared for test on a variety of scleroscope instruments to see whether the use of chilled iron standards should be recommended.

In order to overcome difficulties associated with the hardness testing of chilled rolls the following practice is recommended:—

(1) The Brinell test is not recommended for measuring the hardness of white cast irons such as chilled rolls. For this purpose a rebound type of instrument is preferred, provided the test is taken as indicated below.

(2) The most suitable instrument at present available is the scleroscope of the Shore type, made either in the United Kingdom or in the United States. The original two-bulb scleroscope was superseded about twenty-five years ago in favour of the single-bulb type, but the two instruments give comparable readings, so that where the original instrument is still in use there is no reason for change. Of the single-bulb type two have been made, Type C and the more recent Type C1 of larger capacity. C1 is now made in the United Kingdom, and both American-made and British-made C and C1 instruments are calibrated to original Shore standards and therefore give comparable readings. The more recently developed dial type, D, is known to give higher readings than Type C or C1, and this is estimated at 5 deg. on a chilled roll approximately 100 deg. hard (nominal). It is probable that no scleroscope reading, even on homogeneous and uniform material, can be taken as more accurate than ±1. In other words such readings differing by no more than two points can be regarded as practically identical.

It is understood that a rebound type of instrument made in Germany by Schuchard and Schütte is not now manufactured. It is known, however, that this instrument, which is not a Shore instrument at all, nor calibrated to the same standards, gives readings up to 10 points higher than the Shore type, and the difference is usually taken as about 10 per cent. of the hardness figure.

(3) It is recommended that the test be taken in the following manner:—

An angle iron or saddle is required with a peg at one end, similar to the peg on the fixed stand supplied with the scleroscope, to hold the instrument on the cylindrical roll surface, and a circular level at the other end. Occasionally the relation of the peg with the level should be verified to ensure that the instrument is being used vertically. The hammer is raised by pressing the bulb once only, and it is released by pressing a second time. Care should be taken to allow a few seconds to elapse between the movements to permit the air pressure in the tube to adjust itself. The reading is the highest point reached on the rebound of the hammer, so that it is necessary to make a pilot test to enable the operator to have his eyes fixed on the approximate point reached, but a second reading should not be taken on the same spot. Assistance is given by the pointer, which can be set at any figure, the operator then deciding if the hammer passes that point or not.

A certain amount of experience and judgment is necessary, not only to observe from the correct angle, but also to note accurately the point reached on the decimal scale. Care and attention are required to make an instantaneous reading, and the test must be taken with intelligence and not be regarded as a perfunctory routine to be undertaken by an unskilled operator.

(4) It is recommended that the Shore scleroscope hardness of a given surface be recorded as the average of at least 10 determinations for small rolls, and more for large rolls, in both cases taken along the length of the barrel. Four points per foot run is recommended, excluding lengths of six inches from each end. The second reading must never be taken at the same place as the first, as, apart from the disturbance due to the original surface, work hardening effects cause the second and subsequent readings at the same point to be progressively higher. The surface should be smoothly machined or ground.

## South African Engineering Notes

*(By our South African Correspondent)*

### A Ministry of Transport

A strong plea for the establishment of a Ministry of Transport is made by the General Manager of Railways in his annual report for the financial year 1938–39, which was published late in December. With the development of national roads linking up the larger centres of population, and the spending of large sums of money on the country's road system, he says the need for a change in the existing control and departmental organisation is daily becoming more apparent.

In addition to a transport department under a minister, he suggests the formation of a transport advisory council in order to attain the necessary co-ordination between the different forms of transport and secure co-operation between the various Government departments and provincial and local authorities concerned in transport. This council should consist of twelve members—the Minister of Transport as chairman, a member nominated by the Minister of Transport, the General Manager of the South African Railways and Harbours, the chairman of the National Roads Board, the Central Road Transportation Board, the South African Shipping Board and the Civil Air Board, a member nominated by the directorate of Railways and Harbours, two by the Provincial Consultative Committee, one by local authorities and one by private transport undertakings. This body would advise the Minister of Transport. He suggests further that a directorate of railways should be appointed to take over the administration of the Railways and Harbours subject to the control of the Minister. It should consist of nine members—the General Manager of Railways as chairman, two assistant general managers of the Railways and Harbours; two members nominated by the Minister of Transport, and one each by the South African Agricultural Union, the Association of Chambers of

Commerce, the Federated Chamber of Industries, and the mining industry.

### Increasing Cape Town's Water Supply

A scheme to increase Cape Town's water supply by 4,500,000 gals. a day at very little cost is being undertaken by the Municipality. It will postpone for five years the necessity of laying a third pipe line from Steenbras dam at a cost of £750,000, and thereby save the city nearly £200,000. The scheme is to instal a "booster" plant to assist nature by speeding up the delivery of water which at present flows by gravitation from Steenbras dam. On account of the rapidly increasing demand for water which is likely to be considerably accelerated as the new harbour nears completion and industrial expansion takes place, the city engineer was faced with two alternatives. Either he had to increase the rate of flow through the present pipe line or lay another pipe from Gordon's Bay. The latter alternative meant the outlay of £750,000, while the cost of a boosting pump was only £20,000—less than the capital charges on a new pipe line. Cape Town's present supply of water from Steenbras is nearly 11,000,000 gals. a day and will be increased to 15,500,000 gals. Two years ago it was less than 9,000,000 gals., but with the cleaned pipe line it has been increased by the difference. From all sources, including Table Mountain reservoir, 17,300,000 gals. a day are delivered, but in the hot weather which the city experienced for a week recently, the consumption was between 18,000,000 and 19,000,000 gals. This means that the shortage has to be made up from one of the eight service reservoirs situated in various parts of the Peninsula. The position clearly demanded attention.

The "booster" station will be in Kildare Road, Newlands. Firms in Britain, America, and the Continent have been given the opportunity to tender and the contract will be placed early this year. It is not expected, however, that the scheme will be in operation before the summer of 1941. Centrifugal pumps, each driven by 600 H.P. motors, will be used. It is only possible to "boost" the water in the main steel line from Steenbras. The second cast-iron pipe which feeds the northern suburbs and delivers to Molteno reservoir cannot be forced in the same way. At present water flows from Steenbras at 3·75ft. a second; when the pumps are working it will be speeded up to five feet a second. The scheme is the biggest of the kind in South Africa. The interest and redemption on the pumping plant will be only about £1,000 a year, compared with £37,000 a year if a new line was constructed, making a saving of £36,000 a year for five years.

### Copper from Rhodesia

Copper production in Northern Rhodesia has gone up with a jump since the outbreak of war and the total mineral output of the territory is now certain to reach record dimensions when the end of the year figures are completed, extending well into eight figures in pounds sterling. The Ministry of Supply in Britain has just increased the price of copper from £51 to £62. The magnitude of the increase is difficult to assess as the new quotations include costs, freight, and carriage to buyers' warehouses, plus import duty, whereas the former maxima related to f.o.b. quotations. The increases are, however, substantial, and the immediate effect has been to impart considerable strength to Rhodesian copper shares.

### S.A. Railway Staff Appointments

The following important appointments have been made by the Railway Administration of the Union of South Africa: Mr. D. H. C. du Plessis, superintendent of the Parliamentary section at Railway Headquarters, has been appointed system manager at Bloemfontein in succession to Mr. J. G. K. Agnew who is retiring; Mr. C. H. Hamilton, system manager at Kimberley, succeeds Mr. W. Heckroodt as system manager at Pretoria; Mr. Heckroodt has been appointed understudy to the chief accountant at Johannesburg; Mr. G. H. Dawson, system manager at Windhoek, becomes system manager at Kimberley; Mr. J. Rogan, superintendent (operative) at railway headquarters, has been appointed system manager at Windhoek.

### Industrial Expansion since War Started

More proof, that the war, through its interference with normal trade channels, is encouraging South African manufacturers to begin new industrial enterprises to meet local requirements is furnished by the latest return of new factories supplied by the Department of Commerce and Industries. It clearly shows that the manufacture in the Union of articles which would normally have been imported is already beginning. Fruit boxes and crates, most of which used to come from Scandinavia, are being made by a Germiston concern. Two Johannesburg firms have begun to refine used lubricating oil for resale. High pressure steel pipes with a working pressure of 1000 lb. to 1500 lb. are now being manufactured by a Germiston firm. This is believed to be a new departure in South Africa. In Johannesburg a new factory has begun to make toys. Near the city the manufacture of silicate of soda is about to be started. Near Durban an established concern recently completed an additional factory. One of the articles made there is wooden heels for women's shoes. The firm has now found it necessary to work two shifts a day on the manufacture of these heels, owing to the difficulty experienced by South African shoe manufacturers in obtaining heels from overseas. In Port Elizabeth, a factory has opened for the experimental manufacture of chamois leather products, while in the same city a wool washery which was closed four years ago has been reopened. A Johannesburg steel manufacturing firm has begun to manufacture fire-resisting strong room doors and safes, which formerly were almost exclusively imported. Normal industrial expansion continues on an impressive scale, of which indications are furnished on all sides in industrial areas by the work of extension to established factories which is proceeding.

### A Building Boom

The building trades are quickly emerging from the slackness which followed the outbreak of war. Growing volumes of plans are being passed by the various municipalities, the number of property sales is increasing, and more and more ground is being bought for building sites. A building boom this year, which will continue for a considerable time, is predicted in well informed circles. These are confident that all indications point that way and say that when it comes there is little need to fear that it will be followed by a slump as in the past. In the last war the boom was due principally to the fact that profiteers put up absurdly expensive homes which they could not afford to maintain in peace time, and when they all sold a slump followed. This time, however, profiteering has been nipped in the bud by Government measures, and building prosperity will be founded on a much sounder and more permanent basis.

### £500,000 Woollens Factory

The erection of a woollens factory at Alberton, Transvaal, is being contemplated and a deputation has had interviews with the Minister of Labour, Mr. W. B. Madeley, in Pretoria. The deputation consisted of Colonel P. J. Fick, Mayor of Alberton, Mr. H. J. Zeeman, of Alberton, and Mr. W. E. John, consulting engineer of Johannesburg. The factory would be on similar lines to those in Australia and New Zealand and would be much bigger than anything yet contemplated in the Union. If the project is finally approved it is hoped that for a start the factory will absorb 10 per cent. of the South African fine wool clip. Its range of production would be very extensive, including, besides woollen blankets, clothing, and knitting yarn, and the manufacture of military uniforms. The factory would give employment to about 500 people.

### New Industry for Natal

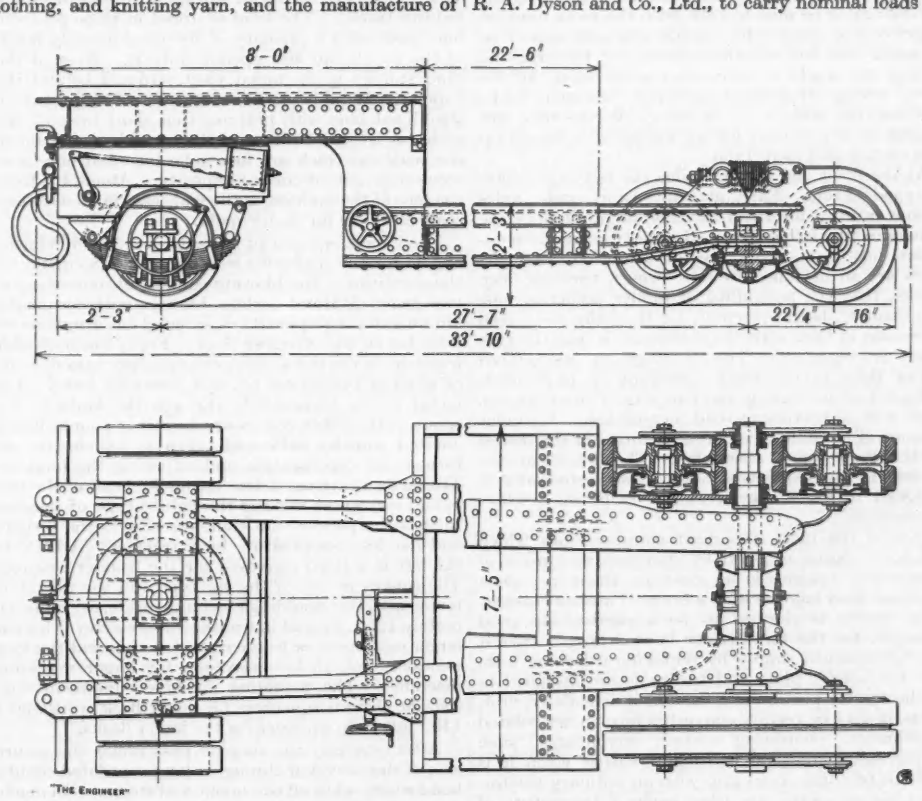
Further industrial developments in the vicinity of Newcastle (Natal) are about to take place. A big industry is to be started at Mattanu's Kraal, adjoining the Newcastle town lands, by Messrs. Barrett and Pillans, a well known engineering firm of Krugersdorp. The intention is to start with the erection of a foundry for castings, the raw material for which will be obtainable from the Newcastle blast furnace which is comparatively near. The farm at Mattanu's Kraal is well known as bearing fine coking coal which was proved some years ago. A preliminary inspection has been made to fix the best site for the foundry. The foundry will probably be close to the national Durban-Johannesburg road which bounds the property. It is also stated that a large number of coke ovens will be erected with a factory for by-products. This new industrial development will be only a short distance from the proposed works of the Bata works (late the Czechoslovakia footwear manufacturers). It is interesting to note that on this farm has been produced the first and only phormium tenax (flax) on a commercial scale in the Union. A large number of plants were put in some years ago and are now well established. These new industrial developments in the ordinary course of events should provide employment for a large number of Europeans and natives.

### S.A. to Produce Farm Machinery

A factory is to be established at Vereeniging which will produce a quarter—and later perhaps more—of South Africa's needs of ploughs, harrows, cultivators, and ridgers, and their spare parts. This is likely to reduce considerably the cost to farmers of these implements. The announcement of the new venture was made by Colonel K. Rood, M.P. for Vereeniging, who stated that the steel industry needed expansion. There is a dangerous shortage of steel, he said, and the position may be so aggravated that the continued operation of the Union gold mining industry may be endangered. The new industry, he explained, was made possible by the present Government's desire to help farmers and to stimulate the production of the steel industry. An attempt was made to establish an agricultural implement factory at Vereeniging years ago, but it failed as the Government of that day refused even to give protection against unfair competition on the part of overseas countries. The need for such an industry in an agricultural country like the Union, which imports agricultural implements to the value of about £1,000,000 every year, and has all the necessary raw materials for such a factory obtainable in the country, is clear. It is sound policy for a country to establish industries for which raw material is available locally and tariff protection is not required.

## Trailer for 40-Ton Loads

THE drawing and photograph reproduced herewith show the construction of a new trailer designed by R. A. Dyson and Co., Ltd., to carry nominal loads of 40 tons, and in particular, large transformers. It has been delivered to Walter Denton, Ltd., well-known operators of heavy-duty vehicles in the North of England, and the design is the result of co-operation between these firms and their associates. The unit has a dropped-frame construction, and is provided with eight wheels, each shod with giant twin tyres. Its length overall is 33ft. 10in. and its width is 7ft. 5in.




ARRANGEMENT OF EIGHT-WHEELED TRAILER

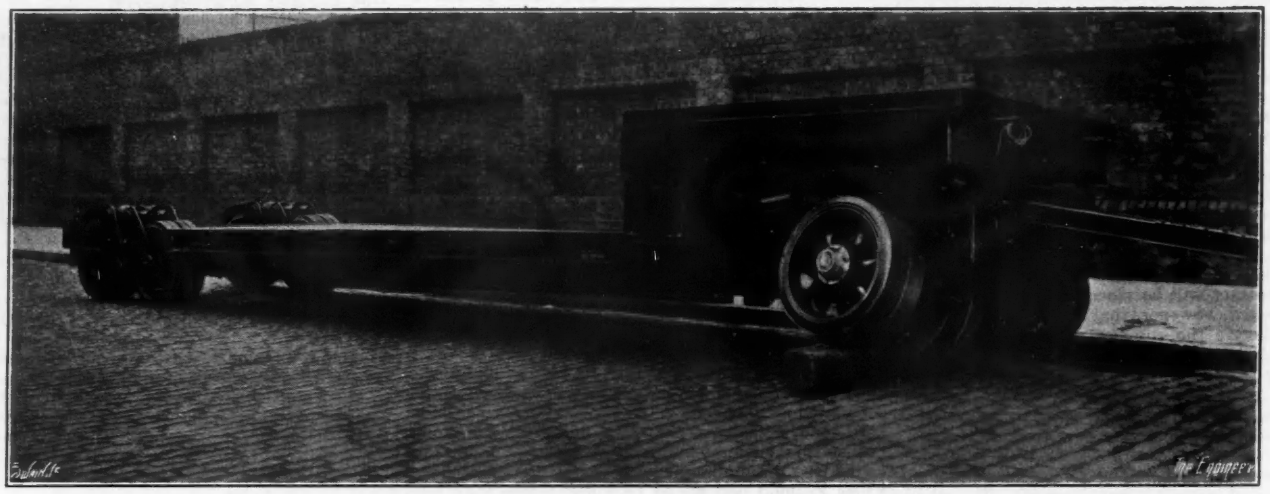
One of the most noteworthy points in the design is the provision of brakes on all eight wheels. Brakes on the front wheels are operated by means of twin Westinghouse vacuum cylinders, the vacuum, of

course, being obtained from the tractor, and therefore the trailer front brakes are applied simultaneously with the tractor brakes upon depression of the pedal. For parking and emergency purposes a hand control is furnished at the near side of the trailer, operating all the brakes on the rear wheels. In construction the brakes are, of course, of the internal expanding pattern, and "Safeguard" liners are fitted, made by the Gandy Belt and Engineering Company, Ltd.

Roller bearings of Timken manufacture are fitted to all the road wheels, with the object of minimising the tractive effort required. As already mentioned, one of the duties of the vehicle is to carry transformers, but the external fittings of this type of apparatus necessitate their being loaded in such a manner that the centre of gravity is to one side of the trailer. Therefore, special attention has been given to the design of the frame, and particularly to the wheel springs, so as to avoid any tendency for the vehicle to "list" by reason of the eccentric loading. Such a tendency might be dangerous on a road with adverse camber. The order for the springs was entrusted to Jonas Woodhead and Co., Ltd., who carefully worked out the deflection rates, and designed the springs to be able to cope with the most unusual conditions in which the vehicle was anticipated to be used. Of half-elliptical laminated pattern, the springs are made of silico-manganese steel, at the front having Woodhead patented trunnion ends, enabling the wheels to oscillate. At the rear end oscillation is provided for by means of a bossed-up axle casting and swivel pin.

At the front end of the trailer the four wheels are arranged in line. Early attempts to fit trailer axles in line, we are informed, invariably resulted in the development of "judder." In this design the complaint has been given special attention, and the axles are so attached to the springs, through deep blocks, that the possibility of judder occurring has, it is claimed, been overcome, for the axles are forced to remain in line, with the consequence that the tyre wear is equalised. The photograph reproduced shows that a considerable amount of movement, independent as regards the two sets of front wheels, is allowed in traversing road inequalities. A similar amount of flexibility has been accorded in the design of the rear wheel assemblies. The frame of the vehicle is particularly strongly constructed and is designed to resist the forces set up by such wheel movements.

One of the most important considerations which has to be borne in mind by designers and users of heavy-duty vehicles is to construct them in such a way that they have as wide a range of uses as possible. This vehicle is claimed to be a particularly good example, for the forecarriage is so arranged that it can be detached simply by removing a locking fork, and the bolster plate and turntable are designed to fit the tractor portion of a Scammell articulated unit. Thus, it may be readily converted into an articulated attachment, conferring certain advantages, such as increased adhesion in rough weather when it is difficult to obtain road grip with an ordinary tractor. Also higher speeds are permissible if the nature of the load is suitable. Alternatively, the carriage can be removed and fitted with a bolster, a twin bolster being fitted to the back of another trailer or Scammell unit, and with this arrangement long loads can be transported, the load itself acting as a "reach."



EIGHT-WHEELED TRAILER FOR 40-TON TRANSFORMERS

THE LIVERPOOL AND SOUTHPORT ELECTRIFIED LINE.—In the article on New Rolling Stock for the Liverpool and Southport Electrified Line, printed on page 109 of the February 2nd issue, we omitted to mention that the motors for driving the two-cylinder air compressers were manufactured by Bull Motors of Ipswich.

## A Canadian Foundry

THERE has recently been completed at the plant of McKinnon Industries Limited, St. Catharines, Ontario, a new foundry which possesses features of considerable interest. The building is approximately 330ft. by 336ft. The main structure consists of one two-storey bay 32ft. wide, extending north and south, and seven 42½ft. bays arranged so that every other bay has its roof about 8ft. higher than the adjoining bays, thus forming a monitor roof construction. The sides of this monitor are fitted with centre pivoted ventilating sashes affording an abundance of light and fresh air for all parts of the building. The walls are of brick and glass and the roof of precast "Hydite." The roof is covered with a smooth surface asbestos roofing to facilitate sweeping off the dust and cinders. The clear space under the roof trusses in the moulding and core departments is 22ft., leaving ample space for the sand distribution equipment and core ovens.

Directly north of the foundry and extending its entire width are the metal storage yard and incoming railway tracks. The sand is stored in three concrete bins, each with a capacity of 800 tons, directly north of the core room and opening into it. West of the sand storage is the metal yard, situated behind the cupolas. Metal is stored on the ground and in twelve steel-lined bins with bottoms that slant towards the scale car track. In front of the metal bins and above the scale car track are four coke bins and one limestone bin, each of one-car capacity. About 4ft. from the face of the building is the scale car track, with two scale cars, one for each cupola.

The cupola equipment consists of a No. 6 Whiting cupola for the malleable iron and a No. 8 cupola for the grey iron. The blowing equipment, consisting of two Ingersoll-Rand turbine blowers with automatic air weighing equipment, is situated on a mezzanine floor below the charging floor. From the malleable iron cupola the metal flows continuously into one end of a 4-ton cylindrical covered receiving ladle. The metal passes horizontally through the ladle to the spout at the other end from which it is poured into a one-ton transfer ladle and taken to an electric arc furnace for superheating and adjusting the mixture. The latter is arranged directly at the head of the two mould conveyors making the lighter type of castings so that the pourers can come directly to the furnace and not lose temperature by a transfer. A little to the left is a third conveyor for the heavier castings. The conveyors are of the car type and the moulding loops, with the moulding machines inside, are approximately 125ft. overall in length. The conveyor for the larger castings is of heavier construction and the loop is wider, and makes provision for larger moulding machines. The moulding machine equipment consists of Osborn squeezers for small flask work and a 14in. jolt strip squeezer for the larger flasks.

After pouring, the moulds pass along the return side of the conveyor through a long ventilated cooling hood which takes off the smoke and steam. On reaching the lower end of the loop, the moulds are ploughed or dumped on to a vibrating shaker-out screen. The flasks and bottom boards are pulled off and returned to the moulders; the sand passes through the screen to a reciprocating conveyor in a tunnel beneath the floor and the castings slide off the screen on to a long oscillating feeder in the same tunnel. This feeder extends past the end of the three shakeout screens, receiving castings from each and slowly conveys them to a 42in. wide apron cooling conveyor running at right angles to it.

The annealing equipment consists of two electrically heated, controlled atmosphere, roller-rail, pusher-type furnaces. Each furnace takes two rows of 30 by 24in. alloy steel trays and has a normal capacity of 170 tons per week. One operator per shift does all the packing and charging and another takes care of the unloading and shot blasting. After shot blasting, the castings go to the sorting belt where they are sorted and classified and sent in boxes to the sprue cutters, the grinders, or the mills as required.

Situated to the east of the malleable iron department is the grey iron moulding department with only a low division wall between to keep the castings from getting mixed. The cupola for this department melts a soft grey iron. The metal for cylinders, pistons, shock absorbers, etc., which is a harder or denser metal, is produced by mixing a proportional amount of the hard iron from the malleable iron cupola with the soft grey iron. Bull ladles filled with the desired mixture are taken to the various stations and transferred to the pouring ladles, thus giving a more complete mixing.

Each conveyor has its own pouring loop and pouring ladles and all conveyors are of the car type with anti-friction bearings and heavy steel plate tops. The first line is for the heavier motor castings such as cylinder blocks, heads, flywheels and lorry brake drums, which can be made of the same iron. After the moulds are poured, they pass through a ventilated tunnel until they reach the far end of the conveyor loop. Here the cores are shaken out while the casting and drag pass around the end of the loop through another tunnel and are shaken out as they start back to the moulding department. A hoist picks up the cylinder blocks, which are hung on the hooks of the overhead chain cooling conveyor. Other castings are placed in open-work baskets and hung on the same conveyor. After cooling the cylinder blocks are placed on a roller conveyor and passed to a swing grinder where the tops and bottom surfaces are ground. They are then tumbled, chipped, hand-ground, sand blasted, and water tested on a line of roller conveyors.

On the second moulding line in the grey iron foundry are made the clutch housing, transmission case, manifold, and intermediate size castings, and on a third line small castings, such as hydraulic brake cylinders, shock absorbers, &c. Between the third conveyor and the core room is the brake drum department with a turntable mounting ten machines that centrifugally cast brake drums in metal moulds, and, after cooling the proper time, eject them on to an apron cooling conveyor. The capacity of the table is about 250 drums per hour, most of the time being taken to cool the mould.

## Fuel in Science and Practice

THE title printed above is that of a monthly journal which for some eighteen years has been known as "Fuel" for short. It began as a supplement to the *Colliery Guardian*, but having rapidly established itself it soon became an independent publication under the Editorship of Professor R. V. Wheeler and Dr. J. V. Elsden. In the beginning "Fuel" was conceived as a clearing house for fuel research and had a distinctly scientific flavour, but always with a view to ultimate practical application. It forms, says an editorial note in the first number of a new volume, "a bridge between the severely academic aspects of the chemical problems involved and the requirements of the practical fuel technologist." We refer to it now because two important events have occurred recently in its history. The first is the appointment of that expert in all fuel problems, Dr. R. Lessing, to take the place which the late Professor Wheeler held with distinction for many years and the second is that it has been adopted as the research journal of the Institute of Fuel. We wish *Fuel* every success in the new phase which it has just entered.

## Rail and Road

CLOSING OF A LINE IN EIRE POSTPONED.—As a result of strong local representation the closing to passengers of the Ballingrane-Foynes line, of the Great Southern Railways of Eire, which should have taken place on January 1st, has been postponed for three months.

PROPOSED ROAD CONSTRUCTION IN TURKEY.—According to the Istanbul correspondent of *The Times*, a plan for the construction of 10,000 miles of road is to be submitted to the Kamutay after the recess. The plan covers a period of ten years and will cost, it is estimated, twenty million pounds.

ROAD ACCIDENTS IN 1939.—Figures compiled by the Ministry of Transport show that 8270 persons were killed on the roads of Great Britain during 1939. The number of persons injured is not yet available. Of the number killed, more than 4100 died as a result of road accidents during the war months, viz. between September and December.

JAPANESE RAILWAY DISASTER.—When a petrol engine driven train was derailed at Osaka on January 29th, the fuel from the engine caught fire and the flames rapidly spread to the coaches. Reports state that more than 170 persons lost their lives and about 70 were injured. The cause of the disaster has not yet been communicated to this country.

L.N.E.R. ELECTRIFICATION SCHEME.—It is announced that notwithstanding the war, the civil engineering works of the London and North Eastern Railway Company's scheme for the electrification of the suburban lines from Liverpool Street and Fenchurch Street to Shenfield are to be completed. Contracts have been placed for practically the whole of the work and good progress has already been made.

THE WATERLOO AND CITY RAILWAY.—It is expected that the Southern Railway Company will have completed its modernisation programme on the Waterloo and City Railway early this summer. It will include a low level connection with the Central London Line. Entirely new rolling stock on the latest principles has been built. When the change over is made, the City Station will be renamed Bank.

NEW INDIAN RAILWAY.—A new 72 miles long metre gauge line was opened at the end of November last between Khadro, on the Jodhpur Railway, and Nawabshah on the Karachi-Lahore main line of the North Western Railway of India. According to the *Railway Gazette* the new extension completes a triangle of lines and is part of a network built mainly for the carriage of wheat cultivated in this area.

TRAIN ACCIDENT CAUSED BY LANDSLIP ON L.M.S.—When the 9.14 a.m. passenger train from Northampton to London ran into a landslip north of Watford on the London, Midland, and Scottish Railway, on Sunday, February 4th, the engine and four coaches were derailed. The landslip occurred at the northern entrance of the Watford tunnel and the up and down lines were both blocked. One woman passenger was killed and several were injured.

PROPOSED NEW VEHICULAR TUNNEL IN NEW YORK.—For some months authorities in New York have been trying to obtain permission from the United States War Department for the construction of a suspension bridge between the Battery on Lower Manhattan and the Borough of Brooklyn. Permission to construct the bridge has been refused and it is now proposed to build a vehicular tunnel carrying four lines of traffic. The cost of such a tunnel would be about eighty million dollars.

PAN-AMERICAN HIGHWAY.—At a meeting of the Society of Engineers in Washington recently, Mr. E. W. James of the Public Roads Administration said that if Guatemala, Salvador, and Honduras are able to carry out their construction programmes, the Pan-American Highway will be two-thirds the way across Honduras by the end of next year. Two-thirds of the 3250 miles of road between Nuevo Laredo and the Panama Canal has been completed and progress is expected to be much more rapid in South America as existing roads constitute fifty per cent. of the route to be followed from Caracas to Buenos Aires.

AUSTRALIAN COMMONWEALTH RAILWAYS.—The financial results in the annual report of the Commonwealth Railways for the year ended June 30th last show an improvement in earnings of £103,554, owing to increased traffic on each of the four railways. On the other hand, the working expenses have increased by £130,239, this increase being attributable partly to the cost of handling the additional business and partly also to the Commonwealth Public Service Arbitrator's Determination and extensive flood damages on the Trans-Australian and Central Australia Railways. Flood damages alone entailed an expenditure of £26,307. The introduction of the faster train service on the Trans-Australian Railway has necessitated considerable additional expense in the maintenance of permanent way and rolling-stock.

YUNNAN-BURMA RAILWAY.—It is reported in *Indian Engineering* that the Chungking Government has decided to complete the last 280 miles of the Yunnan-Burma Railway, to the Burma frontier near Kunlong, on the 60-cm. (2ft.) gauge in the first instance, instead of continuing the metre or standard gauge. It is said that apart from the advantages of the narrow gauge set forth, the decision to introduce a break of gauge is probably influenced by two other considerations: the practical certainty that this Chinese line will not be linked up with the Burma Railways metre-gauge system of Lashio, at any rate for some years to come; and the fact that the alignment of these 280 miles of railway—unlike the mule trade route and, to a lesser degree, the new highway—runs through shut-in valleys of low altitude teeming with the malarial mosquito. For this reason it is almost impossible to obtain or retain labour in the Salween basin, the evil reputation of which went far to prejudice former railway surveys against the Kunlong route, despite its obvious advantages, namely, much less rise and fall and easier gradients than could be obtained for a railway following the more northerly routes.

## Miscellanea

CENTRAL ELECTRICITY BOARD.—The Minister of Transport has appointed the Rt. Hon. Lord Barnby to be a Member of the Central Electricity Board, in place of the Rt. Hon. Sir Andrew Duncan who has resigned his membership of the Board on his appointment as President of the Board of Trade. Lord Barnby was previously a Member of the Central Electricity Board from 1927 until 1935.

POURING TEMPERATURE OF CAST RED BRASS.—The Non-Ferrous Ingot Institute in the United States has carried out a series of investigations on the effects of pouring temperatures and of impurities on the physical properties of cast red brass of the nominal composition of 85 per cent. copper and 5 per cent. each of tin, zinc, and lead. In the earlier investigations, pouring temperatures of 1040 deg. Cent., 1095 deg. Cent., 1150 deg. Cent., 1205 deg. Cent., and 1260 deg. Cent., were used, but in later work the temperatures were restricted to 1065 deg. Cent., 1150 deg. Cent., and 1230 deg. Cent. It was found that the pouring temperatures usually had a greater influence on the physical properties of the alloy than had certain intentionally added impurities.

HYDRO-ELECTRIC PROGRESS IN CANADA.—The annual review of hydro-electric progress in Canada prepared by the Dominion Water and Power Bureau, Department of Mines and Resources, shows that during 1939 considerable activity took place not only in the installation of new generating capacity but also in the extension of transmission and distribution facilities in many parts of the Dominion. There was also a substantial increase in the demand for power, reflecting steady growth in domestic use and increased activity in mining, pulp, and paper and many other industries. New water-power installations in 1939 aggregated 97,040 H.P., which with an installation of 1400 H.P. omitted from the 1938 review, brings the total for the Dominion at the end of the year to 8,289,212 H.P. The greater part of the increase, amounting to 87,441 H.P., was made up of extensions to existing stations in Saskatchewan, Ontario, and Quebec.

FIRE FIGHTING IN ELECTRICAL INSTALLATIONS.—In a discussion on the report of the British Electrical and Allied Industries Research Association on fire fighting equipment for electrical installations at the Institution of Electrical Engineers last month, Mr. H. Nimmo said that the report needed amendment to bring it into line with the Electricity Commission Report. He pointed out that this E.R.A. report showed that the various media used in the tests could be successfully applied by expert representatives of the manufacturers, but it left the user wondering which system he ought to apply to his own installation. He considered that water, properly applied, was the most certain means of putting out any fire, and the cooling effect gave it a tremendous advantage over foam, $CO_2$, methyl bromide, or carbon tetrachloride. The problem might be solved by using automatic atomised water installations for outdoor and indoor transformers and oil and bitumen filled switchgear, and ordinary water sprinklers for cable basements and places where oil was not likely to be present. He would prefer at least ten minutes' water supply in the storage tanks at, say, 60-lb. pressure, to the four or five minutes and 50-lb. suggested in the Report.

STRUCTURES UNDER AIR ATTACK.—We have received from the Ministry of Home Security a copy of some notes by Professor J. F. Baker on the resistance to collapse of structures under air attack. It is pointed out that while in an air attack on a factory a direct hit can scarcely fail to interfere to some extent with production, the damage will be much more widespread and costly if, at the same time, a main member is weakened and leads to the collapse of a large area of the building. Fully-framed steel or reinforced concrete structures are comparatively resistant to collapse, since they are capable of adjusting themselves to heavy overloads for which they were not specifically designed. As a result of the somewhat conservative values of working stresses hitherto assumed in design in Great Britain, the majority of modern buildings will be comparatively resistant to collapse, even when subjected to serious structural damage. Certain types could, however, be made more resistant by slight amendments in design and detail. In the notes, particular problems are not dealt with, but the attention of designers is drawn to general points which should be considered when designing new structures or strengthening existing ones.

THE LATE MR. H. W. RAVENSHAW.—By the death of Henry Willock Ravenshaw, which occurred on January 12th, at the age of 81, the electrical industry has lost yet another of its early pioneers. He was born in Worcestershire and spent most of his boyhood days at Malvern. He obtained his first engineering experience in the railway shops and also in engineering works on the North East Coast. In 1886 he was with Goolden and Trotter at Halifax, where he was associated with the late Ll. B. Atkinson designing dynamos for central stations, and motors for haulages, pumps, and coal cutters in mines. A few years later the firm amalgamated with Easton and Anderson of Erith, and Mr. Ravenshaw spent a few years in their service designing electrical plant including some of the first electrical lifts for the Underground Railways. In the early '90's he joined Mr. R. Booth and practised as a consulting engineer in Cannon Street, under the title of Booth and Ravenshaw. The partnership continued for a few years until Mr. Booth retired and Mr. Ravenshaw continued the business in Cannon Street, afterwards removing to Rutland House, Hanwell. He specialised in the application of electric power to iron and steel works, industrial factories, and collieries. He was the patentee of a magnetic clutch which was applied to electrically driven units such as ram pumps for hydraulic work, reversing tables for planing machines, and also to motor cars, and he incorporated one of these clutches in a motor car which he built himself in 1900. In 1919 he took Mr. C. F. Dyer into partnership and continued in active business until the firm removed to Doncaster in 1925, when Mr. Ravenshaw took up his residence in Grasmere and eventually retired from the business in 1930. He was a very active member of the Institution of Civil Engineers, and contributed many papers to that Institution as well as to the Institution of Mining Engineers and the Royal Socety of Arts.

## Air and Water

THE LIFEBOAT SERVICE.—During January boats of the Royal National Lifeboat Institution rescued 272 lives from shipwreck, bringing the total number of lives saved since the outbreak of war up to 1273.

A NEW JAPANESE CANAL.—Work is in progress on the construction of a canal 22 kiloms. long between Tokyo and Yokohama. It will have a width of between 600 m. and 700 m. and will be 9 m. deep. It will be constructed by way of Morigasaki and the mouth of the Tama River near Haneda.

INDIAN AERODROME IMPROVEMENTS.—Reports from India state that sanction is to be sought in the next budget for the expenditure of large sums upon the modernisation of a number of civil aerodromes to suit them for military purposes. It is expected that work will begin shortly on the aerodromes at Madras, Bombay, and Calcutta.

UNITED STATES SHIPPING.—The annual report of the United States Maritime Commission states that in connection with the ship replacement scheme, 129 of the 141 new ships built or under construction have been allocated to specific trade routes. The 141 ships for which contracts have been placed have an aggregate deadweight tonnage of 1,440,000.

THE WILBUR WRIGHT MEMORIAL LECTURE.—The twenty-eighth Wilbur Wright Memorial Lecture before the Royal Aeronautical Society will be delivered on Thursday, May 30th, 1940, in the Lecture Hall of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2 by Dr. Roxbee Cox on "The Future of Civil Aviation."

THE BRITISH CORPORATION REGISTER.—It is announced that Mr. A. Murray Stephen, chairman of Alexander Stephen and Sons, Ltd., has been appointed chairman of the Technical Committee of the British Corporation Register of Shipping and Aircraft in succession to Sir Maurice Denny. Sir Maurice has occupied the position for fifteen years and has resigned on account of the many other calls upon his time.

SHIPPING CASUALTIES.—During the week ended Sunday, January 29th, one British ship of 1523 tons, two French ships of 6588 tons, and thirteen neutral ships totalling 33,996 tons were sunk by enemy action. Up to January 24th, there were 7388 ships escorted in British convoys and of these only 15 were lost, one of them being a neutral. Enemy merchant vessel losses include 21 ships captured and 3 ships sunk by the Allies, and 23 scuttled.

AN UNUSUAL MOTOR CRUISER.—At the annual National Motor Boat Show in the United States there was exhibited an unusual design of motor cruiser built by Higgins Industries, Ltd. It has a peculiar bow form, the fore foot being cut away and continued in a smooth curve from the bow to the stern of the bottom of the hull. This design has for its principal object to introduce a film of air between the hull and the water, but it also gives the boat other useful characteristics. It can mount, without damage to itself, banks or sand bars, and its heavy extended keel protects the rudder and propeller to prevent damage when the boat slides over such obstructions when travelling at speed.

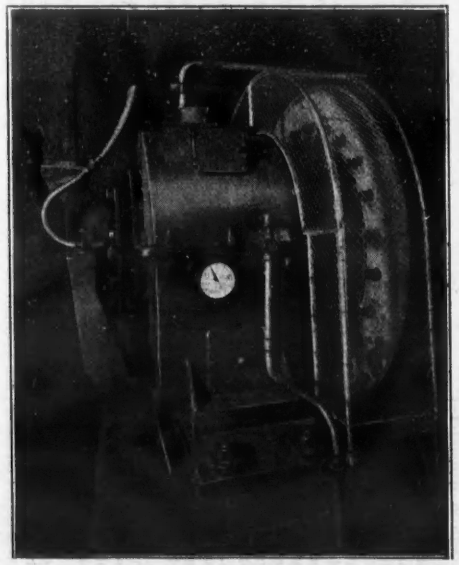
NEW AMERICAN LINERS.—A recent issue of the *Journal of Commerce* gives further details of the two new liners which the United States Maritime Commission proposes to have built. They will be the largest yet built in America, and are intended for service in the Pacific. Their dimensions will be as follows:—length, 759ft., overall beam, 99ft. 9in., overall depth, 78ft. 6in., and maximum draught, 32ft., the gross tonnage being between 35,000 tons and 35,500 tons. The design will be such that the ships can be rapidly converted into aircraft carriers with accommodation for 75 aeroplanes. The funnels will be set on one side and light armour plate will be used in the construction of the hulls. It is estimated that each ship will cost between three and four and a half million pounds each.

AIRCRAFT MANUFACTURE AND AVIATION IN JAPAN.—An article in the *Far Eastern Review* deals with the progress of aircraft manufacture in Japan. It is stated that the industry has not kept up with the progress made in other countries and the types of machines and engines follow closely the design of foreign models. In order that better machines may be made without excessive costs the Aircraft Manufacturing Industry Law was made last year and under it the Government gives protection and encouragement to manufacturers, and a licence system prevents an excessive increase in competitive factories. A Central Aeronautical Institute has been organised to carry out a five-year research programme at a cost of 50 million yen. A number of training schools for flying personnel are being set up in the country and a Central Institute for Aviators at Matsodo is to be opened this year for the training of professional aviators for regular air transport companies. Several landing fields are to be laid down and a number of existing airports extended.

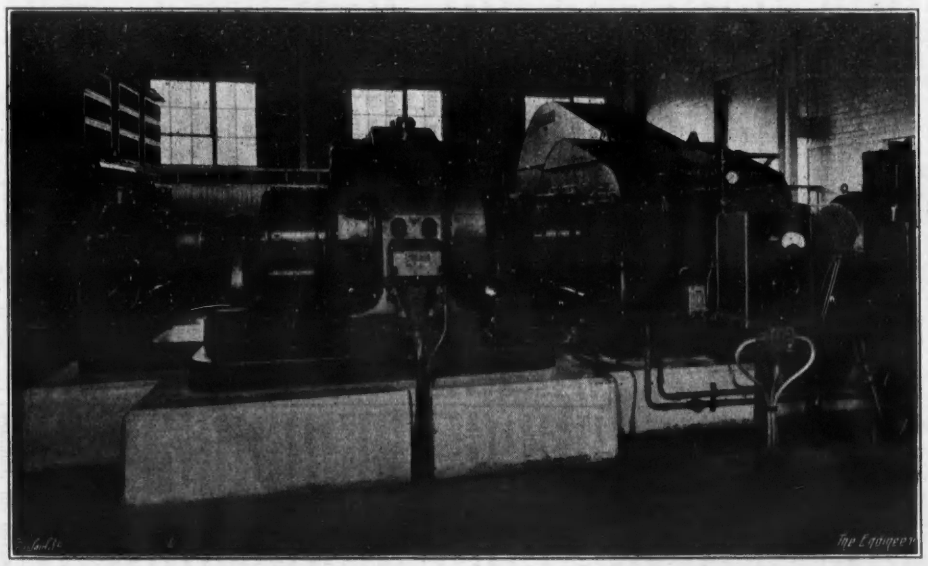
CONTROL OF TRAFFIC AT PORTS.—The Minister of Transport has informed the Port Emergency Committees established at the principal commercial ports that in certain circumstances he would be prepared to make a local Order applicable to a particular port, when he was satisfied that serious congestion is threatening or has occurred or that one or more of the transport facilities serving the port are working under particularly heavy pressure. The effect of the Order when made is that the Port Emergency Committee may designate to an importer a means of transport (whether by road, rail, canal, or coastwise shipping) which will be available during the ensuing 48 hours for the removal of the goods from the port. If the goods are not removed within that period the Committee may cause the goods to be conveyed to the place to which they are addressed (or to any other place at which it is reasonable to require the owner to take delivery) by any means of transport which the Committee think fit, at the risk and expense of the owner and subject to a lien for the expense. The Order will not, without specific renewal, be in force for longer than one month.

## TUBE MILL FOR CEMENT GRINDING

(For description see page 140)

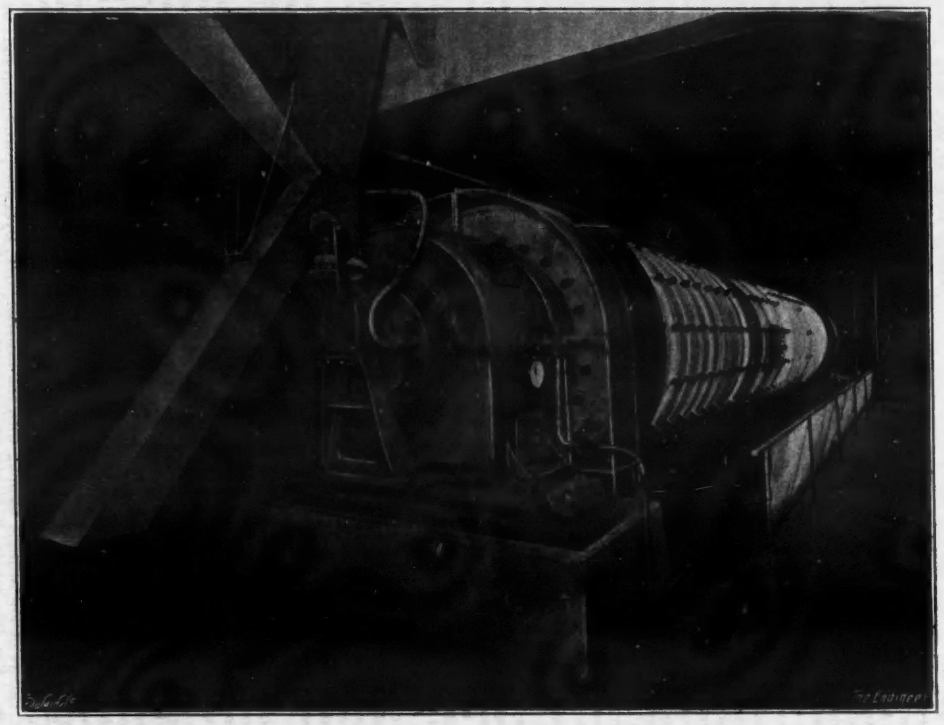


FEED END MAIN BEARING

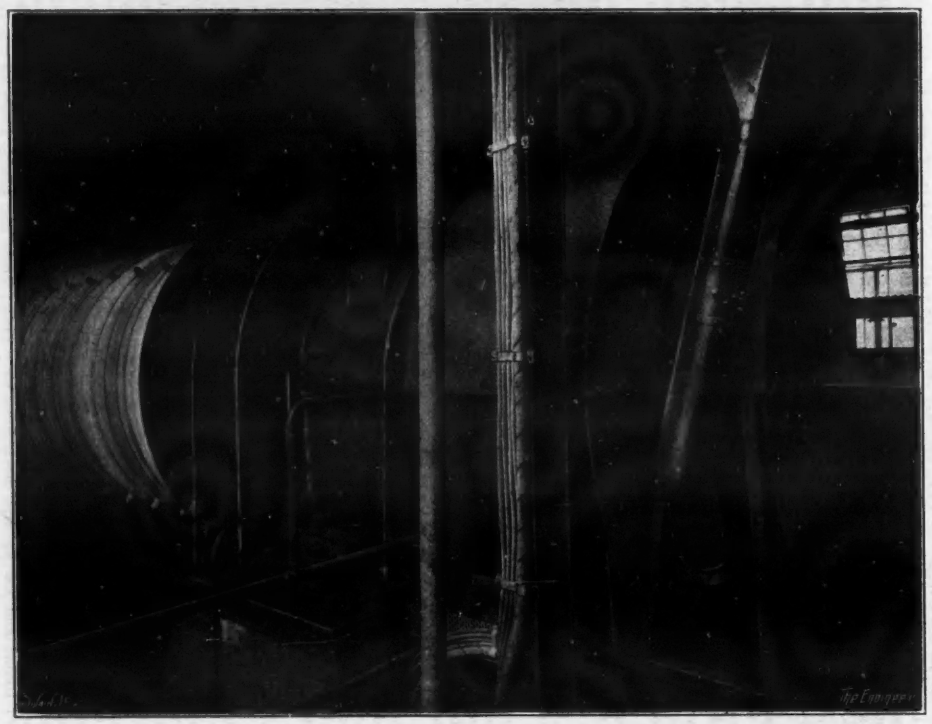


800 H.P DRIVING MOTOR AND GEAR-BOX

DISCHARGE END MAIN BEARING



FEED END



DELIVERY END

# The Engineer

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## THE LOCATION OF INDUSTRY

INDUSTRIAL Britain has grown up in its own way ever since it began. Long before the so called Industrial Revolution accelerated its pace it was settling its own problems in its own way with very little let or hindrance. But there was always wisdom in its methods. Manufacturers did not drop down haphazard on an open field and say "Here we will build our factory." They were fully alive to economic considerations. They knew that they must be near their markets, or near the great ports, or near the raw material, or they might be influenced by natural conditions like the air of Lancashire or the waters of Hallamshire. But they do not seem to have troubled their heads overmuch about labour. They had no need to do so. The industry drew the labour to it. In consequence the density of local populations increased more rapidly than the accommodation, and a host of evils arose. It is usual to lay the blame on industry for those conditions. But that is scarcely fair. It did not occur to anyone that it was the part of industry to find homes for its workers. In those days the responsibility of industry ended at the works gates. The employer was not expected to meddle with the private affairs of his workpeople. He had his own affairs to think of. They revolved primarily upon making money for himself, but he could not do that without enriching Britain as a whole. Hence, he brought to this country the wealth upon which its present status of life has been built up. There were enormous sacrifices to be borne. On the one hand, the condition of the workers, even measured by the scale of their day, was deplorable; on the other, many and many a fortune was lost in unsuccessful ventures. But taken all for all the free and easy method was successful. Industry did not ask for help from the Government and it resented interference. It was confident that it knew best how its affairs should be conducted and was ready to fight its own battles.

In the course of years, and with increasing acceleration, a great change has taken place. Industry is controlled in a hundred ways; the employer is no longer a free agent. The methods of our fathers and grandfathers have gone by the board and the principle of individualism of which they were so proud has been shaken. Industry, considered by and large, is now looked upon as a unit and part of the politico-economic system. The Government, instead of leaving it to its own devices, is ever more and more exercising control over it. It cannot do what in its wisdom and knowledge it believes to be best, but is required to do what the Government deems to be best in the interests of the community as a whole. It fights against the restraint, but the power of those who are confirmed believers in corporate planning increases. The principles of the totalitarian powers are creeping upon it. In the course of time the last shreds of individualism in industry will have disappeared. Industry will do what it is told to do by a Department of State. The recently published Report of the Royal Commission appointed to enquire into the "Distribution of the Industrial Population" is the latest patent example of the trend of industrial policy. That Commission was set up in 1937 and for nearly two years took endless evidence. The essential point to be settled one way or the other was whether industry should be allowed to settle down where it deemed best or whether it should be constrained to settle in areas prescribed by the Government. In a debate in the House of Commons in 1936 the President of the Board of Trade, Mr. (now Lord) Runciman, said that the Government was unable to accept the principle of compulsory location, but subject to that proviso and on the understanding that it was the spirit rather than the letter of the motion which was involved, he agreed to accept without a Division a motion that steps should be taken to prevent further industrial development around London by diverting new undertakings to the Special Areas. That was good enough for the "planners." They know well enough that the "spirit" in political affairs gives way to the "law." Permanent officials prefer definite rulings to permissive ones. The outcome could therefore have been foreseen. It is expressed in the conclusions of this Report of which the first and essential one is that "A National Authority be established by Statute for the purpose of making research into, advising upon, and *regulating the location of industry*." We have italicised the vital words. There were differences of opinion amongst the members of the Commission on the nature and power of the National Authority, but all were agreed that the location of industry must be controlled.

It is extremely improbable that the Report will be adopted by the House or even debated as long as the war lasts. For the time being, industry is virtually under State control and no new Authority is required to restrain it. Furthermore, it may happen that when peace returns to Europe such changes will have already taken place in the social and industrial system that the work of the Commission will be valueless. But if ever it is debated we shall not be surprised if the charge is brought against it that the conclusions are not in accord with the evidence, or that the value of the evidence has been changed by subsequent events. For example, the Report was written and concluded when war was imminent and stress is laid, in consequence, upon the strategical dangers of industrial concentrations—or "urbanisation" as it is called. If a really permanent peace is reached strategy will be forgotten. But this must be said for the Report. It is extremely fair and conscientious. A Commission of another composition might have come to different conclusions, but at any rate this Commission has honestly examined the problem even if it seems to have paid rather more attention to ideas than to hard facts. Thus to us it appears that the evidence of the F.B.I. and of Mr. A. C. Macdiarmid, chairman of Stewarts and Lloyds, Ltd., that interference with the right of industrialists to fix the location of works would be fraught with danger was overpowering. Obviously, the Commission did not regard it in that light and we may presume, without examining the vast volume of the minutes of evidence, that this attitude to the opinion of industry itself was held consistently, and that it has been rejected wherever it was opposed to the schemes of those who are convinced "planners" in the public interest and therefore opponents of individualism. Well, perhaps they reflect the temper and trend of the times, and we must look forward with what complacency we can command to the time when all the principles upon which it was firmly believed for a hundred and fifty years that the success of British industry was founded are of no more worth than the winds of yesterday.

### Silence

"THERE was silence in heaven for the space of half an hour" records the writer of the Apocalypse, before a scene of dire judgement is depicted: it was not the silence of weakness, but rather of great power, a fitting prologue to the events that followed. It is not difficult to find an analogy at the present time, when under war pressure the great value of silence is prone to be ignored. Even the merit of the silence of ignorance is appreciated by Shakespeare when he causes Gratiano to exclaim:

"O my Antonio, I do know of these,
"That therefore only are reputed wise,
"For saying nothing."

The young engineer, anxious to write a telling report, often by assuming a knowledge that he does not possess and by his foolish remarks excludes useful assistance that he might have secured, for had he but maintained strict silence and an attitude of keen observation, and recorded facts and nothing but facts, he might eventually have been able so to grasp the situation that he could prepare an intelligent report. The engineer at the beginning of his career would be well advised to act on the advice given by the worldly wise Polonius to his son Laertes when about to leave the parental roof, "Give every man thine ear, but few thy voice."

But at the present moment it is the silence of power that we have primarily before us, a silence not easy to attain, and one that may readily be misunderstood. In days when nerves are tried

by war conditions, when new problems are arising on all hands, and when more than ever there are temptations to unguarded words and hasty action, the need for cultivating the art of silence is most apparent. Many managers can probably recall occasions when they have made "spot" decisions of which they have momentarily been proud, but which later have led to much trouble; indeed they would subsequently welcome any opportunity to reverse their judgement if it did not imply a degree of "losing face." A valuable piece of machining may be ruined beyond repair, and so exasperate the experienced manager that he summarily dismisses the operator responsible for the mishap as a punishment to the offender and a warning to others; in reality he may have inspired a feeling of insecurity in the minds of all his men, and a latent spirit of resentment which will not readily be lived down. If on the other hand the manager had received the tidings of the accident in silence, only asking for the full facts to be ascertained, with a view to marshalling them in a quiet judicial manner, extenuating circumstances might be brought to light, a good employee might be saved to the company, and a quiet confidence established in the workshop. It is seriously suggested that if the gift of silence were more assiduously developed the labour turnover would be noticeably reduced. Perhaps the fact that the senior official has the last word makes it the more incumbent upon him to avoid ill-considered speech, but the subordinate official has much to gain by also fostering the power to be silent as occasion demands. It is not easy to swallow what appears to be a studied insult, there is a definite temptation to score at the expense of the unjust chief with a retort that is pertinent and truthful and seasoned with just that spice of acidity that is calculated to find its mark, yet the triumph is but short lived and likely to be the harbinger of further trouble. If on the other hand the insult is received in silence, subsequent developments may show either that it was not even intended, or that it was regretted almost as soon as uttered. The unjust accusation taken silently tends to make the accuser ashamed of himself or certainly anxious to make sure of his ground, and finally to show by his later actions that he has genuinely appreciated both the silence of his subordinate and the fact that he desisted from retaliation when it was really justified. Silences of this sort tend to promote more harmonious relations. If what we have said is true, it will be readily admitted that cultivation of the art of silence would reduce the likelihood of strikes and other industrial upheavals. The fact that we are frequently impelled to adjourn meetings, is in itself an indication that we tacitly admit the value of periods of silence. It might even be well to have regular silences introduced into some of our business meetings!

To the constructive mind silence is as essential as the air we breathe. Pity the poor managing director who allows himself to be harassed by his staff at all times, and who has neither the power nor the will to go into periodic retreat silently to consider his problems, to determine his line of action, and methodically to plan for the future. During these periods of absolute silence no one should be permitted to intrude on any pretext whatever. In many of the half baked schemes that have been launched, only to founder miserably, it has not been difficult to diagnose that the originator has not even discovered the value of a term of silence for quiet contemplation and meditation. The man who would reorganise a business is courting disaster if he does not allow himself a long spell of silence before attempting any reform. Frequently the designer of complicated mechanisms is expected to evolve something that is revolutionary in character, but he is also expected to do so amid the clatter and hubbub of the general drawing office, with no opportunity for that silence which he instinctively knows is essential, but which can only be secured after office hours. Similarly the man who plans mass production by modern methods is often hampered by having to work in the same room as his assistants, and be liable the while to a series of interruptions from above and below. "Speech is silver, silence is gold" is as true to-day as when first uttered, and it is submitted for the serious consideration of British industralists in these difficult days, that they pay more heed to the necessity for a careful study of silence as a commercial attribute.

## Literature

*A Romance of Industrial Engineering.* By JAMES A. MORRIS. 1939. Kilmarnock: Glenfield and Kennedy, Ltd. Price 15s. 6d.

IN this volume the author, chairman of Glenfield and Kennedy, Ltd., records the history of that firm from its beginning. He relies largely on the minute books of board meetings, but adds welcome personal touches, and illustrates the whole by a large number of excellent portraits which in themselves breathe the essence of Romance. There is Mr. Thomas Kennedy himself, with his large mouth, firm but kindly eyes, side whiskers meeting under his chin, and a huge black bow which may have been of silk or velvet. Then we have Mr. Alexander J. Bruce, another notable character in the Kennedy romance, with a face as round as that of his contemporary, Mr. Pickwick, and the suggestion of a body harmonious with it; later we come to portraits of "Four of the Earliest Workmen," and a lovable lot they look, all bearded or bewhiskered, with one, Mr. William Watson, looking like a younger and plumper Abraham Lincoln. On another page, there is a group of portraits of early directors, one of which, Mr. John Borland, is remarkable for the unconventional "posing" of the eyes, and another is imbued with all the self respect and conscious integrity of Mr. Pecksniff—unlike as the two characters were. "Dr. James Hamilton Bruce" attracts the attention on another page, recalling as he does the make-up of a performer in "The Green Table" we believe it was. Yorkshire whiskers with a heavy black moustache, great eyebrows, and a bald domed forehead. Other portraits bring us up to the present day, from full beards, through moustaches, and so to the era of the safety-razor. A whole history there is in this portrait gallery, for it takes us back to a time when our fathers were young and brings us down to the very present.

The invention of the Kennedy water meter in 1852 was the start of the business. Thomas Kennedy was the patentee, but certainly not the sole and original inventor. The principle seems to have been imagined by Mr. Alexander J. Bruce, a banker, who got Kennedy, a gunsmith of Kilmarnock with engineering proclivities, to put it into form. But the registering index was beyond his capacity, and he gave that part of the problem to Mr. John Cameron, a clockmaker, to solve. He "after long pondering and more than one failure, found light, it is related, on a Sunday morning while worshipping in King Street Church. During the sermon, Mr. Cameron had been abstractedly making various pencil diagrams on the fly-leaf of his Bible, when the germ of the solution flashed across his mind; whereupon in his ecstasy, enraptured by his vision and oblivious of his surroundings, he rose hurriedly to his feet, audibly ejaculating 'By God, I've got it now!' and like a man possessed, walked out of the sanctuary to tabulate immediately and more fully his inspiration." The Bible with the diagrams remained for many years in his pew "To witness if I lie." Thus once again the Sabbath asserted itself in Scotland as a day pregnant with philosophic—and financially profitable—contemplation. Was it not "in the Green of Glasgow on a fine Sabbath afternoon" that the inspiration of the separate condenser was given to Watt?

The meter, having been brought into a practicable shape, a syndicate of four Kilmarnock worthies was established to work it. Later the syndicate changed its name, and constitution, and became the Kennedy Patent Water Meter Company, with a nominal capital of £10,000. That was in 1865 and nine years later Kennedy died.

We must turn to the Glenfield Company. The works of the syndicate were at Townholm and adjacent to them was Townhold Foundry. The foundry supplied the works with its castings and there was much friendly intercourse between the members of the two firms. But it occurred to a Mr. John Murray, who at one time had worked in the foundry, that it would be a good thing if the syndicate had its own foundry. The suggestion was therefore put forward by a group of workmen, anxious to further their own interests, that a complementary meter works foundry should be established. They brought the suggestion to Mr. Bruce and Mr. Kennedy, who were taken with it, but carried the idea further, and proposed the formation of a foundry and general engineering company, and offered to finance the promoters. This scheme was accepted, and for the sum of £400 the works and grounds of Neil's Glenfield Print Works, then in liquidation owing to the decline of cotton printing in Kilmarnock, were bought by Bruce and Kennedy, and transferred to the Glenfield Company. Murray was a man of great energy and the moving spirit in the new works. He lived till he was ninety, and worked to the end, dying in 1916.

The final step in the constitution of the firm as it now is took place in 1900 when the two firms which had worked together for thirty-five years were amalgamated into one. "There was," Mr. Morris says, "no abrupt change, no sharp cleavage of ideas and effort, but a steady continuity of progress and work under the same board and management, the same offices and shops—in other words the same overhead staff and output control."

A word should be said about the spirit that has characterised the firm since its inception. Kennedy was for his day an outstanding example of a humane employer. It has often happened that the workman turned employer has proved a hard and unsympathetic master. But it was not so in this case. Kennedy was a straightforward, fair dealing, conscientious man, and his workpeople were his friends. The spirit which he introduced has prevailed through the years, and to this day it is as strong in the Kilmarnock works as ever it was.

One more word about this volume before we close it. Some of it will be dry reading to those who are not in the firm, for, as we have already said, it relies a great deal upon the minutes of board meetings recording events which have often little general interest. The author, no doubt, recognising this fact, has opened his book with a chapter of reflections of an old employer by way of introduction, and follows it with notes on Kilmarnock. In these essays the human and romantic touch prevails, and both are very pleasant reading.

## BOOKS RECEIVED

*The Electrical Year Book*, 1940. London: Emmott and Co., Ltd., 28, Bedford Street, W.C.2. Price 1s. 6d. net.

*Modern Armaments.* By A. M. Low. London: Scientific Book Club, 111, Charing Cross Road, W.C.2. Price 2s. 6d. net.

*Electrical Timekeeping.* By Dr. H. Spencer Jones, M.A. London: N. A. G. Press, Ltd., 26–28, Old Street, E.C.1. Price 10s. net.

*Jigs, Tools, and Fixtures.* Second Edition. By P. Gates. London: Technical Press, Ltd., 5, Ave Maria Lane, E.C.4. Price 10s. net.

*This Strange World.* By A. E. Trueman, D.Sc. London: Scientific Book Club, 111, Charing Cross Road, W.C.2. Price 2s. 6d. net to members.

*The International Mercantile Diary and Year Book*, 1940. London: The Syren and Shipping, Ltd., 46, Leadenhall Street, E.C.3. Price 12s. 6d. net.

*Human Relations Manual for Executives.* By Carl Heyel. London: McGraw Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 12s. 6d. net.

*Lloyd's Register of Shipping Rules for Electric Propelling Machinery and Electrical Equipment.* London: Lloyd's Register of Shipping, 71, Fenchurch Street, E.C.3.

*Early British Locomotives.* By C. F. Dendy Marshall, M.A., M.I. Loco. E. London: Locomotive Publishing Company, Ltd., 3, Amen Corner, E.C.4. Price 12s. 6d. net.

*Modern Steels: Manufacture, Inspection, Treatment, and Uses.* Edited by E. E. Thum. Ohio: American Society for Metals, 7016, Euclid Avenue, Cleveland, U.S.A. Price not stated.

*Metal Working Tools and their Uses.* Revised and Enlarged Edition. By Percival Marshall. London: Percival Marshall and Co., Ltd., 60, Kingsway, W.C.2. Price 1s. 6d. net.

*The Modern Workshop and Workshop Practice.* By R. Bernard Way and N. D. Green. London: Wells, Gardner, Darton, and Co., Ltd., Craven House, Kingsway, W.C.2. Price 3s. 6d. net.

*Steel Construction and Broad Flange Beams, Grey Process.* Handbook No. 22. London: R. A. Skelton and Co. Steel and Engineering, Ltd., Moorgate Station Chambers, E.C.2. Price 10s. net.

*Micrometers, Slide Gauges, and Calipers.* By A. W. Marshall, M.I. Mech. E., and G. Gentry. London: Percival Marshall and Company, Ltd., 60, Kingsway, W.C.2. Price 1s. 6d. net.

*Boulder Canyon Project Final Reports.* Bulletin 3. Model Tests of Boulder Dam. Bulletin 4. Stress Studies for Boulder Dam. Colorado: United States Department of the Interior, Bureau of Reclamation, Customhouse, Denver. Price 2 dols. net per copy.

## Letters to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents)*

### BRIDGE CALCULATION

SIR,—I have just read with interest your criticism of my book "Bridge Calculation and Design." In it you have referred to Chapter 6 in which you write that I have "presented a moment table for reactions and bending moments applied to the British Standard Loading for Railway Bridges and states in his preface that as far as he is aware this has not been published before. Moment tables applied to Coopers loadings were published more than a quarter of a century ago and a similar table applied to an actual British locomotive was published in THE ENGINEER about the same period." If you had read my preface correctly you would have found that I state that moment tables have not been applied as far as I am aware to the British Standard Loading before. Coopers moment tables, as you must surely know, are all in American Loading.

As regards the determination of the equivalent U.D.L. "the old-fashioned method," as the reviewer calls it, was adhered to because of its universal application. One does not always want to construct a moment table when one wishes to determine the equivalent U.D.L. for any system of wheel loads.

I should be pleased if you would publish this letter. DAVID Y. HILL.

Maidstone.

[Quoting from Mr. D. Y. Hill's preface, he writes :—"Stresses have been calculated by the approximate method, by influence lines and by moment table. The latter has been applied to the British Standard Loading and, as far as the author is aware, has not been published before." This is a definite statement that, as far as the author is aware, the moment table has not been published before. Hence the correction.

We in our turn must take exception in Mr. Hill's use of the words "universal application" in the last paragraph but one of his letter, having proved by long experience that a suitable application of the moment table is by far the quickest and most accurate method of determining equivalent uniformly distributed loads for a concentrated load system applied to a range of spans, and knowing that this method has been in use for many years, by engineers at home and abroad, in preference to the graphical method originally employed which Mr. Hill describes in Chapter 7 of his book.—THE REVIEWER.]

### OUTPUT AND UNDERSTANDING

SIR,—We have marked with unusual interest the article which appeared under the above heading in your issue of December 29th. To our minds the psychological argument raised, while of importance at any time, is too frequently overlooked. Nowadays, however, when so much depends on the enthusiasm of the worker, it would seem to us to demand the serious attention of those in authority. An illustration from our own experience of the truth of the contention put forward in your article may not be without interest.

For our peace time products we depend on workers whose interest in the machines they are constructing is almost traditional and who possess an extraordinary familiarity with the functions of these machines. Our fitters not only accompany our installations to the factories of our customers, but must possess the knowledge and experience to produce in those factories the exacting results demanded. Beyond this, however, it is a commonplace of the life of the community from which we draw our workers for members of the same household to be employed, some in our own works, others operating our machines in local factories. From this there has grown up over years a community of interest and an habitual appreciation of the problems involved in the very complicated business of preparing and spinning fibres.

In common with other engineering firms we have of late undertaken the manufacture of numerous lines, the purpose of which is outside our normal purview, and we have at times been at a loss to account for the apparent disappearance of some of the intelligence and applicability of our labour force when diverted to these new lines. It occurred to us on reading your article that the writer had, in a large measure, indicated the reason.

Obviously it is beyond the capacity of private firms to educate their workers to an intelligent appreciation of the functioning and importance of the strange new pieces they are producing nowadays. Therefore, while the desirability for some such educative effort as is suggested is, to our minds, inescapable, it is clear that only those in authority can provide the means. If ever a provision of this kind were contemplated by the authorities we, as one firm no doubt among thousands, would be most anxious to co-operate.

"A NORTH COUNTRY TEXTILE MACHINERY MAKING FIRM."

[The suggestion made in the last paragraph of this letter strikes us as admirable. The Ministry of Supply would experience little or no difficulty in finding a small number of competent lecturers who would visit firms and explain to the workpeople in an interesting manner the character and vital importance of the work on which they are engaged.—ED. THE E.]

### DRYING OUT FLOODED ELECTRICAL MACHINERY

SIR,—Your article of the above title in a recent issue of THE ENGINEER described the work of reconditioning the Ontario Power Station after having been put out of action due to ice. In November, 1925, at Dolgarrog in North Wales, a reservoir dam burst, destroyed part of a village and flooded the North Wales Power Company's hydro-electric stations. At the time I was associated with the North Wales Power Company, and the following brief outline of the work of recommissioning the stations may be of interest.

The plant consisted of two 5000 kW. Pelton driven horizontal alternators and a number of smaller sets, A.C. and D.C. The disaster occurred about 9 p.m. and water rushing into the station was the first warning received by the staff. Quickly they shut down the sets, then escaped for their lives. The water carried thousands of tons of stones, sand, and mud which completely filled the basements and buried part of the auxiliary equipment. Speedily the flood increased and deposited the mud to within about 2ft. below the turbo-alternator main shafts.

The following day gangs of men with shovels and barrows started to dig out the plant. As soon as sufficient clearance was made the alternator end shields and winding guards were removed. Round the lower part of the windings, core, and rotor, there was a thick caking of mud which was carefully brushed off. The machine bearings were dismantled and cleaned, and the lubricating system was thoroughly washed out and refilled with oil. No damage had been done to the turbine.

Slowly the set was run up to about half speed so that the air circulated by the rotor fans would dry the outside of the windings. After about 15 hours, the machine was shut down and a quantity of the dried mud brushed off. A short circuit was connected across the main terminals and the machine run up and excited for drying out. The method proved to be satisfactory and within ten days of the flooding the first 5000-kW machine was on load and gave entire satisfaction.

There were squirrel cage motors which remained buried in wet silt for days. The motors, when dug out, were carefully washed with water, then placed in an oven until the windings were dry and gave a good insulation test. Potential and current transformers which had been immersed were replaced with new transformers. A storage battery used for switch operation and control purposes was completely buried and filled with silt, the cells were dug out, dismantled, washed and re-assembled. The battery afterwards gave good service.

On the night of the disaster sixteen people in Dalgarrog lost their lives. In the village there were assembly rooms which were built on high ground away from the flood. There was only one performance of pictures per week: the films were showing to a full house at the time of the disaster. Everybody in the cinema was saved, but if the flood had taken place at any other time the loss of life would have been far greater.

GEOFFREY GERARD. A.M.I.E.E.

Kirkcudbright, Scotland,

## Sixty Years Ago

### THE NATURE OF ELECTRICITY

IN a leading article in our issue of February 6th, 1880, we took Mr. (Sir) W. H. Preece to task for suggesting in his presidential address to the Society of Telegraph Engineers (the Institution of Electrical Engineers) that electricity was a form of force. There was, we said, internal evidence in the address that Mr. Preece was joking and that, viewing the prevalent dearth of controversy, he had had the happy idea of presenting an address containing the greatest possible number of ideas directly antagonistic to received teaching. Nevertheless, Mr. Preece was the president of a learned society, and until we were better informed we were bound to take the statements he made as representing his deliberate opinion. Preece contended that electricity was not a form of matter but a form of force. We replied with the statement that all his arguments demonstrated with equal satisfaction that electricity was a form of matter and not of force. Strangely enough we were able to quote Clerk-Maxwell—"a giant against whom it was dangerous to contend"—in support of our contention, and in one of the severest passages in our article we accused Preece of rashness in daring to criticise the late Professor's statements. The modern reader will have little difficulty in finding the clue to the conflict of opinion. As in so many controversies—scientific and otherwise—the dispute rested entirely upon a difference in the usage of words. In this instance the trouble, for once, did not arise from a misapprehension of the difference between "force" and "energy," nor from a failure to recognise that heat was a form of energy. Preece, Clerk-Maxwell, and ourselves were correctly informed in these respects. The trouble lay in the use of the word "electricity" in a lose manner—as standing at times for a current of electricity and at times for electrical energy. A clear understanding of the meaning of the words ampere, volt, and watts would have brought everyone into agreement. Indeed, possessing that understanding the modern reader can see that Preece, Clerk-Maxwell, and ourselves were all actually in substantial agreement concerning the nature of "electricity." To illustrate the confusion of argument which gathered about the subject we may quote an example mentioned in our article. Consider, we said, a circuit containing an incandescent wire. A galvanometer inserted on either side of the wire showed the same deflection. The quantity of electricity passing on one side was the same as on the other. Yet the wire emitted heat and gave off light—both forms of energy. What kind of force was it, we asked, which could thus expend itself and at the same time suffer no loss ? Faced with this dilemma some people, we noted, argued that the current, although the same on both sides of the incandescent wire, was less than what it would be if the wire were not present and that the difference between the two currents was the electricity used in producing the light and heat in the wire. We would have nothing to do with this argument for, we said, that which did not exist could not produce light and heat. The truth was enshrined in Clerk-Maxwell's words which Preece misinterpreted and criticised, and which we used to support a false argument. Energy, said Clerk-Maxwell, is produced by the multiplication of "electricity" and "potential" and it is impossible that "electricity" and energy should be quantities of the same category; "electricity" is only one of the factors of energy. the other factor being "potential." . . . For "electricity" read amperes, for "potential" read volts, and for the product read watts and we see that Clerk-Maxwell's words express the modern view of the subject except in so far that the product is power rather than energy.

## Institution of Mechanical Engineers

The following list of awards for papers has been issued by the Institution of Mechanical Engineers.

Thomas Hawksley Gold Medal and Premium.—Mr. J. J. P. Dolan, A.M.I. Mech. E., and Mr. W. G. Jackson, B.Sc., "An Investigation into the Permissible Load-Carrying Capacity of Steel Wire Ropes for Hoisting with Special Reference to Deep-Level Winding on the Witwatersrand Goldfields" (Proceedings, 1939, Vol. 142).

George Stephenson Prizes to Mr. Adolf Meyer, E.D., "The Combustion Gas Turbine; Its History, Development, and Prospects" (Proceedings, 1939, Vol. 141). Mr. F. W. Lanchester, LL.D., F.R.S., Hon. M.I. Mech. E.,* "The Energy Balance Sheet of the Internal Combustion Engine" (Proceedings, 1939, Vol. 141).

Water Arbitration Prizes to Mr. Alex. Taub "Cylinder Bore Wear" (Proceedings, 1939, Vol. 141)., Mr. S. A. Wood, M.Sc., and Mr. A. Bailey, "The Horizontal Carriage of Granular Material by an Injector-Driven Air Stream" (Proceedings, 1939, Vol. 142).

Starley Premium to Mr. E. C. Ottaway, A.M.I. Mech. E., "Motor Transport" (Proceedings, 1939, Vol. 142).

Herbert Ackroyd Stuart Prizes to Mr. E. Giffen, Ph.D., M.Sc., M.I. Mech. E., and Mr. A. W. Rowe, Ph.D., B.Sc., A.M.I.Mech. E., "Pressure Calculations for Oil Engine Fuel-Injection Systems" (Proceedings, 1939, Vol. 141). Professor S. J. Davies, D.Sc., Ph.D., M.I. Mech. E., "Recent Developments in High-Speed Oil Engines" (Proceedings, 1939, Vol. 141).

Thomas Lowe Gray Prize to Mr. A. H. Goodger, M.Sc.Tech., "The Examination and Tests on Welded Parts for Steam Power Plant" (Proceedings, 1939, Vol. 142).

T. Bernard Hall Prizes to Mr. Owen A. Price, M.I. Mech. E., "Vortex Pumps, or, Slip in the Centrifugal Pump" (Proceedings, 1939, Vol. 142). Mr. C. W. Newberry, B.Sc., G.I. Mech. E., "An Investigation into the Occurrence and Causes of Locomotive Tyre Failures" (Proceedings, 1939, Vol. 142).

* "Dugald Clerk Prize."

# Tube Mill for Cement Grinding

THE rapid expansion which has taken place in the cement industry during recent years has been encouraged by progressive improvements in cement machinery, brought about by intelligent co-operation between cement works managers and engineers and the makers of cement plant. An example of a recently built plant is a 7ft. 3in. diameter by 39ft. long tube mill, which is grinding Ciment Fondu at the works of Lafarge Aluminous Cement, Ltd., of West Thurrock, Essex. It is illustrated by a number of engravings on these pages and page 136. Ciment Fondu is said to be the strongest and most rapid-hardening cement yet developed. These very characteristics, however, result in Ciment Fondu clinker being far more difficult to grind than Portland cement clinker, and when it was decided to install an additional large Ciment Fondu grinding mill some eighteen months ago it was considered necessary to build a machine of special design, embodying improvements and features not at that time available on mills of standard construction. This machine was built by Ernest Newell and Co., Ltd., of Misterton, near Doncaster. It is of all-welded steel fabricated construction.

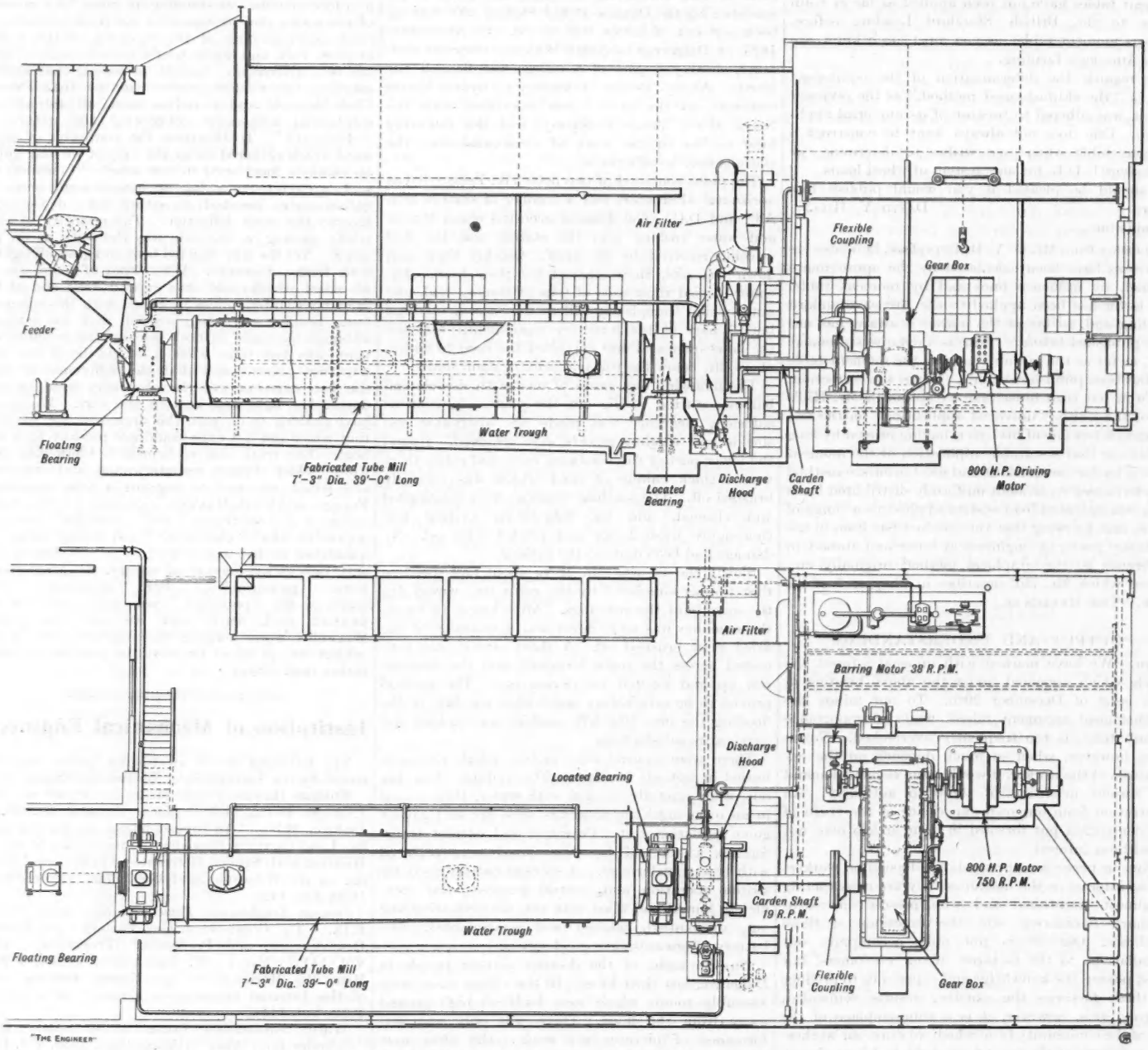
The shell or tube is 1¼in. thick, and is rolled from three mild steel boiler plates. The circumferential and longitudinal joints are electrically welded and no rivets are used on any part of the machine. The end plates are also of all-welded construction, fabricated from boiler plate, and are claimed to be much stronger and more rigid than cast steel end plates. The makers state that cast steel end plates, particularly on large mills, are difficult to manufacture, and must, of necessity, be made with numerous ribs and of heavy section to obtain strength. A risk of hidden flaws or blow-holes consequently arises. But with the fabricated end plates made from rolled steel plate, the material is homogeneous and of even density, and can be made of lighter section with adequate ribbing. No allowance has to be made for the risk of open metal, blow-holes, or hidden flaws.

In addition, the firm's patented method of welding the end plate directly into the shell eliminates the angle flanges necessary on ball and tube mills of conventional design, and is claimed to result in a still stronger and more rigid job. The trunnions are mild steel castings suitably machined and registered to bolt to the end plates and accurately turned and polished to suit the bearings. The main bearings are also of novel construction. The housings are completely fabricated from mild steel plate. The bearing surface of best quality white metal is arranged in the lower half of the bearing housing, no cap or top half bearing being employed. The upper half of the housing forms a chamber in which windows are provided, and an electric lamp fitted to the top of the housing illuminates the interior. Lubrication is effected by Newells cascade flood oiling system. The oil circulation is continuous, and is effected by a disc mounted on the trunnion, close to the end of the bearings. The lower tip of this disc is submerged in an oil bath, and carries up a film of oil on the surface as it rotates along with the trunnion. Fixed in the top of the housing is an oil trough suitably drilled to deliver a series of streaming jets of oil directly on to the upper part of the rotating trunnion. Suitable wipers are attached to the trough to deliver the oil from the feeding discs into the trough. As the upper half of the trunnion is exposed inside the bearing housing, the streaming jets of oil completely flood the upper rotating half of the trunnion with lubricating oil, which ensures an adequate and continuous film of oil being carried between the trunnion and the lower half bearings. The inlet trunnion is of large size, to enable the raw material to be fed freely by means of an enclosed chute directly into the first chamber of the mill.

The mill is divided into four compartments, and special liner plates are used in each compartment. Owing to the very hard nature of Ciment Fondu, special care was given to these liner plates to obtain progressive effective grinding in each successive compartment, each of which has a different type of plate. The total charge of grinding medium is 50 tons, and the total weight of the mill and gear-box is 180 tons. The ground material is discharged by means of suitable lifters through the hollow discharge trunnion into a discharge hood, from which it is conveyed to the storage and packing plant.

A "Visco-Beth" dust collecting plant is installed and connected to the outlet hood of the mill, thus placing the whole plant under suction. In addition, the outlet hood of the mill is protected by two annular air ducts, which are maintained at a slight pressure of air, so effectively preventing the escape of dust to the atmosphere. The atmospheric conditions and surroundings of the mill are comparable with a well-kept turbine room in a power station.

The mill is cooled on the outside by water spray to remove the heat generated in the mill by the grinding process. The special bolt fixing used for securing the liner plates to the shell effectively prevents the water from penetrating to the interior of the mill.




ARRANGEMENT OF TUBE MILL FOR CEMENT GRINDING

### GEAR-BOX AND DRIVING ARRANGEMENTS

The mill is driven through carden shaft and flexible coupling, and double reduction gears supplied by Turbine Gears, Ltd., of Cheadle Heath, Stockport. The normal power transmitted is 800 H.P., with usual overloads. The motor runs at 750 r.p.m. and the mill at 19 r.p.m. The mechanism is designed for a continuous twenty-four-hour per day duty. The first reduction single helical gears are placed on each side of the second reduction double helical gears. The large final wheel is of fabricated construction.

The gears run on double-row self-aligning roller bearings mounted on taper sleeves. Lubrication is by spray to the first reduction gears from an oil pump and by oil bath to the second reduction gears.

Motor and high-speed shafts are connected through a flexible coupling, whilst a special diaphragm coupling with a torsion shaft forms the connection between the final reduction shaft and the mill end. These diaphragm couplings and torsion shafts have been specially developed by Turbine Gears, Ltd., for cement and other mill drives. Self-contained barring gear, which is mounted on an extension bed-plate, allows the mill to be revolved at $\frac{1}{2}$ to $\frac{1}{4}$ r.p.m. and is capable of automatic disengagement.

### Electric Driving Motor and Control Gear

The electric motor was supplied by Crompton Parkinson, Ltd., of Chelmsford. It is an 800 H.P., 750 r.p.m., auto-synchronous machine, controlled by automatic contactor type control gear interlocked with a suitable oil switch. It is designed to operate at a maximum of 0·9 leading power factor on a 3300-volt, three-phase, 50-cycle system, and is capable, therefore, of considerable power factor improvement, which is required by other motors on the same works. The stability of the machine is such that power factor is adjustable between unity and 0·9 leading by means of a control pedestal incorporating an exciter shunt field regulator and a moving coil excitation ammeter. When the grinding mill is run alone the power factor is adjusted to unity in order to secure maximum efficiency, and the losses are so reduced that an electrical efficiency approaching 97 per cent. at full load is said to be realised. At the same time, the overall efficiency of the plant can be raised and the power costs reduced by increasing the excitation and thereby effecting power factor improvement, and under this

TUBE MILL SEEN FROM FEEDER PLATFORM

condition the auto-synchronous motor runs at the unusually high figure of 96·1 per cent. at 0·9 leading power factor at full load.

The maximum starting torque likely to be required on this particular mill is one and a-half times the full-load value, for which a primary current of approximately 180 per cent. of the full-load value would be required. Under actual working conditions the starting torque required does not exceed 80 per cent. full load, and the starting current is in the neighbourhood of the full-load value. This excellent performance is obtained by a special arrangement of the secondary windings, which ensures a concentrated field form under running conditions while retaining a distributed effect with a complete iron circuit to produce the induction motor characteristic at starting.

Control of the motor is effected by means of an oil-immersed circuit breaker made by George Ellison, Ltd., of Birmingham, interlocked and interconnected with an automatic contactor panel supplied by Contactor Switchgear, Ltd., of Wolverhampton. The contactor panel consists of a pillar type sheet steel case of dust and drip-proof construction, having hinged inspection doors and containing seven double-pole rotor contactors, together with the necessary control and starting relays. These relays are arranged to provide a warning period to men who may be working in the grinding mill department prior to the starting up of the motor. The sequence of operations during starting is as follows :—

Depression of the start button energises a Klaxon alarm, which is arranged to sound for fifty seconds. When thirty seconds have elapsed the circuit to the no-volt, no-close device of the high-tension stator circuit breaker is completed, thereby enabling the stator circuit breaker to be closed by hand. This condition is indicated by the lighting up of a white indicating lamp mounted on the panel. If the circuit breaker is closed the motor starts with all rotor resistances in circuit, this resistance being subsequently short-circuited in seven steps by closing of the rotor contactors. The contactors are under the control of mechanical timing devices which are mounted on the contactor shafts, and are easily adjustable to suit the starting load. If the circuit breaker is not closed within fifty seconds of the depression of the start button, then the control and starting relays all become de-energised, and to start the motor it is necessary to re-press the start button. Shutting down of the motor is effected by depression of the stop button. The motor will also shut down as a result of overload, voltage failure, failure of the machine bearings oil pressure, or stoppage of the cement pump. The pilot circuits for the various safety features are fed from a separate low-tension single-phase supply which can be made available through a separate transformer from the main high-tension supply.

In addition to the main motor there is a small barring motor which is connected by means of a clutch to the mill gearing, and which is suitable for turning the cylinder very slowly for feeding-in purposes and for adjusting its position to an exact spot. By a suitable arrangement of shielding on the "stop" and "start" push buttons it is impossible to operate the main "start" button while the barring motor is running, and *vice versa*.

We are indebted to Mr. C. M. Kay, works manager of Lafarge Aluminous Cement; Mr. P. Howden, of Ernest Newell and Co., Ltd.; Turbine Gears, Ltd., and Crompton Parkinson, Ltd., for the information necessary to prepare this article, and to the late Arthur H. Moss, late managing director of Ernest Newell and Co., Ltd., who was very closely associated with the design and installation of this plant.

## The Haweswater Dam*

By DELWYN G. DAVIES, B.Sc., (Eng.), Assoc. M.I.C.E., Assoc. M. Inst. W.E.

During the period 1905 to 1915, in view of the steadily increasing demand for water, the Manchester Corporation Waterworks' Committee decided to investigate further possible sources of supply. This investigation led to the recommendation of Haweswater, the most easterly of the lakes in the English Lake District and about 80 miles from Manchester, as being the most suitable catchment to meet the future requirements of the Corporation and the twenty water authorities dependent upon them. By the Haweswater Act of 1919 and subsequent Acts, the Corporation was empowered to purchase the watershed of 23,820 acres, to construct a dam at Haweswater, two dams and several intakes in the neighbouring valleys, an aqueduct from Haweswater to Manchester, and other ancilliary work. The whole of the watershed is mainly fell-land, and is sparsely populated; it lies between the levels 690ft. O.D. at the site of the Haweswater dam and 2718ft. O.D. at the summit of High Street.

The first instalment of the scheme, which is intended to augment the existing supply from Thirlmere, consists of the construction of the dam at Haweswater, 9 miles of aqueduct from Haweswater to Garnett Bridge, and $2\frac{1}{4}$ miles of pipe-line from the terminus of this aqueduct to the Thirlmere line at a point situated 3 miles north of Kendal. The aqueduct and pipe-line are now complete, whilst the dam is expected to reach completion by the autumn of 1940. The dam at Haweswater is being constructed about 100 yards below the natural outlet of the lake, the level of which will be raised by 9·55ft. to 790ft. O.D. to provide an available storage capacity of 18,500 million gallons. The present surface area of the lake will be increased from 342 to 974 acres, and its length from $2\frac{1}{4}$ to 4 miles.

### Rainfall and Yield

The annual average rainfall for the whole scheme varies from 97in. at Bleawater (1465ft. O.D.) to 52·0in. at the north-easterly part of the watershed; the mean annual rainfall is about 75in. and the estimated mean yield 83 M.G.D., of which 9 M.G.D. must be passed down the rivers as compensation water. The catchment for the Haweswater reservoir has an area of 7970 acres, a high mean annual rainfall of 81·7in., and an estimated mean yield of 33·6 M.G.D.

### Floods

A compound rectangular overflow sill to the spillway, stream-lined in section and having a total length of 227ft., is situated at the centre portion of the dam. It is designed to deal with standard floods, the peak head of which is 1·93ft., as calculated according to the recommendations of the Institution of Civil Engineers Provisional Report of 1933. A detailed examination of previous floods at Haweswater during the past 13 years show that none has had an intensity approaching that of the standard, although very heavy rainfalls have been experienced, *e.g.* 5·83in. in 15 hours. Unfortunately, no float recorder on the lake was available, but level readings were taken twice daily and more often during heavy storms. These figures on interpolation, together with the chart records of the outflow, showed that the period of concentration for a catchment of 7970 acres was of much longer duration and the peak much lower than the standard maximum adopted by the report. This may be explained by the topographical features of the catchment. The formation of two of the three valleys feeding Haweswater provides considerable lag effect to the run-off and reduces the influence of the steep slopes of the remainder of the catchment. This is due in one of the valleys, Mardale, to the existence of two small tarns, Bleawater and Smallwater, whose combined area is 56 acres; in the other, Fordingdale, a hanging valley, to the inundation of the alluvial flat in the valley bottom, These two valleys comprise over one quarter of the total catchment.

* Extracts from a paper in the December Bulletin of the Liverpool Engineering Society.

### Choice of Dam

The topography and geology of the wide valley with its solid rock foundations extended the range of structures to be considered. For such a site the traditional type is a solid masonry or concrete gravity dam. To-day, however, there are available equally sound structures, but more economical. These modern alternatives termed buttress or deck dams are entering into serious competition with the normal gravity type, especially on sites similar to that at Haweswater. They usually consist of a series of buttresses each supporting a face slab termed the deck, and are, therefore, hollow gravity dams. In contrast to the almost vertical upstream face of the normal gravity dam, that of the buttress type is inclined.

The advantages to be gained from the buttress dam are as follows :—

(1) Reduced uplift pressure on the dam base.

(2) The utilisation of the weight of water on the upstream face to ensure stability.

(3) Prevention of percolation through, and the consequent deterioration of, the vital down-stream portion of the dam.

(4) Access for inspection of the foundations and the concrete of the dam near the upstream face.

(5) Improved heat dissipation of the concrete during construction as provided by the many exposed surfaces.

(6) Economy of materials.

The decks which transmit the water pressure to the buttresses have many variations of design, namely multiple arch, fixed slab, cantilever slab, simply supported slab, and sectoral slab. These and the buttresses may be classified into two groups, one comprised of thin highly reinforced members, the other of massive members with little or no reinforcement. The latter require more materials than the former, but the costs of additional materials are generally offset by the lower costs of construction.

### The Haweswater Dam

The Haweswater Dam is a monolithic buttress dam built of massive sections. It consists of 44 independent buttresses widened at their ends to form continuous up and downstream faces. The upstream splayed part, termed the buttress head, cannot be regarded as a true deck because of its monolithic character and its comparative large dimensions. The dimensions are tabulated below :—

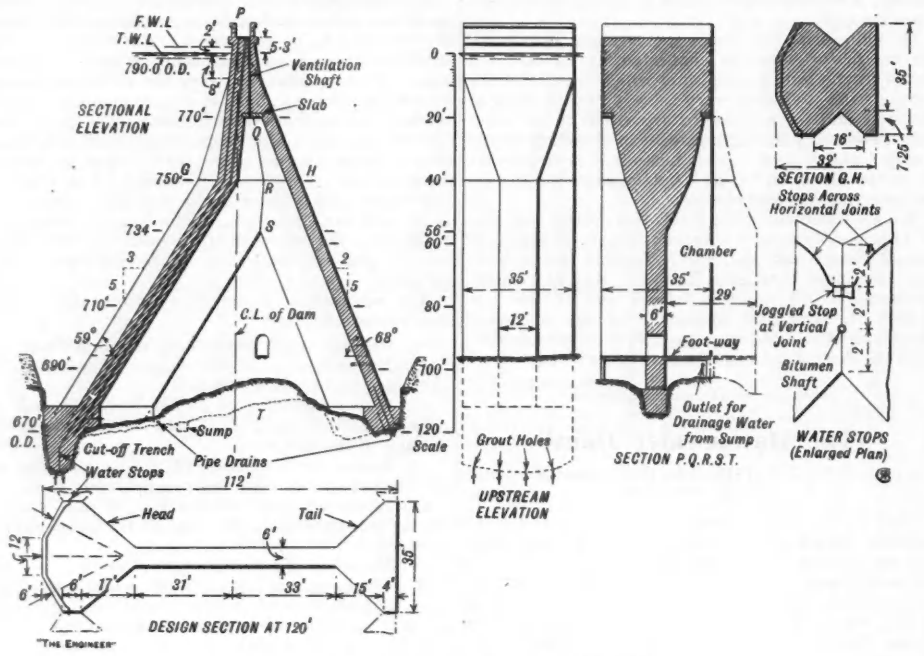
| | |
|---|---|
| Overall length ... ... ... ... ... ... | 1540ft. |
| Length of each block ... ... ... ... | 35ft. |
| Maximum height from lowest foundations to footway level ... ... ... | 144ft. |
| Maximum height from ground level to T.W.L. ... ... ... ... ... ... ... | 100ft. |
| Base width at 120ft. below T.W.L. ... | 112ft. |
| Width at T.W.L. ... ... ... ... ... | 7ft. 9in. |
| Total estimated volume of concrete ... | 140,000 cubic yards. |
| Total estimated volume of concrete required for solid dam ... ... ... | 192,000 cubic yards. |
| Total estimated volume of concrete saved ... ... ... ... ... ... ... | 52,000 cubic yards. |
| Total estimated volume of excavation... | 77,000 cubic yards. |

An examination of the accompanying drawing will reveal that every buttress has two distinct features, a bevelled face to the head and a splayed tail. The head and tail converge upwards and eventually merge, forming a solid dam for the top 20ft. This top part of the dam covers a series of pyramidal chambers, each formed by adjacent buttresses. Each chamber at 120ft. below T.W.L. has maximum plan dimensions of 96ft. by 29ft. wide, *i.e.*, an area of 2320 square feet. One hundred feet above this level the chamber terminates in a plan section of 5·75 by 2·6ft. An individual buttress, therefore, is analogous in shape to a tapered I-sectioned cantilever fixed vertically, the head and tail forming the flanges. Some idea of the economy of materials of this type of dam, in comparison with a solid dam, may be gained from a similar comparison between a rolled steel joist and a rectangular sectioned joist of equal strength.

Four entrances through the downstream face of the dam permit access to the exposed foundations forming the base of the chambers, and examination of the head to within 6ft. of the water face. An interior footway passes through openings made in the narrow portions of the buttresses and bridges the chambers. Interior lighting and drainage is provided throughout. Two 36in. diameter scour-pipes, each line furnished with a sluice guard valve and a needle valve, are controlled from within the dam, and convey the compensation water through the dam to the stilling pool. An auxiliary scour pipe of 40in. diameter through the dam at a higher level is intended

for alternative use or to assist the other lines in emptying the reservoir during an emergency. A 12in. scour pipe is also available. Their maximum collective discharge is estimated to be 520 M.G.D. Concrete and metal grills are fitted about the intakes of the pipes. The supply intake for Manchester is situated at the upper end of the lake, about 2¼ miles from the dam.

The stilling pool receives both compensation and flood waters, which are measured over a weir situated at the pool exit. Under flood conditions the pool will have a maximum depth of 9ft. adjacent to the downstream face of the dam. Of the many varied suggestions for preventing serious scour of the rock foundations in the shallower parts of the pool below both ends of the spillway, a compound rectangular overflow weir to the dam was considered the most




DESIGN OF BUTTRESS OF HAWESWATER DAM

suitable. This provides a head of water spilling over the dam roughly proportionate to the depth of water in the pool.

### DESIGN

The buttress head forming the water-resisting member of the structure is practically the most important. It is of unusually large dimensions, having an area of 45 per cent. of the total horizontal sectional area of the dam at 120ft. below T.W.L. The shape of the head provides an almost ideal distribution of the principal stresses and shear throughout. A plane-faced head was not favoured because in this form it would react theoretically under external load as a double cantilever. Although the tensile stresses at the face would be limited to a low maximum of 54 lbs. per square inch at 120ft. below T.W.L., the tendency to crack formation whether light reinforcement was used or not was considered a disadvantage. The adopted design has bevelled wings to the face, which eliminate bending and diagonal tension (except that due to dead loading) by directing the lines of external pressure within the concrete. A curved face would have served the same purpose, but at a higher cost of construction.

Each buttress has a length of 35ft., measured along the centre line of the dam. This was thought to be a safe measurement for the type of mass concrete to be used, in order to be free from cracks. Moreover, the head and tail of the butrress, in sectional plan from 120ft. to 50ft. below T.W.L., approximate to a polygon and a triangle in shape respectively ; the vertical cross-sectional areas through their centres of gravity, transverse to the centre line of the dam, are considerably greater than those areas at parallel sections. It is believed that these central enlargements increase the resistance to shrinkage crack formation at their mid-sections.

The splayed tail, in contrast to the downstream portion of the normal buttress of rectangular section, offers greater lateral stability and resistance against buckling under load. In order to prevent buckling, the normal type usually requires lateral support when the length-thickenss ratio is greater than 12, by means of struts between adjacent buttresses. The Haweswater dam obviates this, but it is admitted that the quantity of concrete required is thereby increased. The series of splayed tails form a continuous downstream face. This is necessary for the spillway portion of the dam ; by enclosing the space between the buttresses, a more even internal temperature is maintained, corresponding to within 10 deg. Fah. of the water temperature. Thus the head is protected from the effects of both differential temperatures and weathering.

Every buttress is completely independent of its neighbours in order to avoid torsion.

With the intention of preventing water from passing through the vertical joints at the junction of adjacent heads, joggled copper stops 10in. wide by 1/10in. thick, and 2ft. back from the water face are concreted in place half in each head. The joggled part of the stop projects 2in. and is coated with bitumen paint to avoid adhesion to the concrete. This allows for contraction of the buttresses and their slight differential movement without fracturing the metal. This movement will probably continue until impounding is complete. Behind and parallel to the copper strip is what may be termed the second line of defence, a 4in. diameter hole halved by the vertical joint and filled with bitumen. The bitumen surrounds a 1in. diameter pipe through which steam is passed to heat and melt the bitumen which enters the joint.

A considerable reduction in uplift in comparison with that of a solid dam is made possible because the exposed foundations between the buttresses of the hollow dam provide an effective drainage. If the chambers were to be completely free of water, uplift at the inside periphery of each head would be zero ; but for design purposes this pressure was assumed to vary from half the static head at the upstream face to tail water pressure at the inside periphery. A constant pressure equal to tail water pressure was assumed for the remainder of the buttress.

The quantity of concrete in cubic yards per foot run required for the Haweswater dam is tabulated below ; by way of comparison, figures for a normal gravity dam having a base width of 90ft. for a height of 120ft. are shown. Unless optimistic assumptions regarding uplift pressures were made this base width would probably be exceeded.

| Height in feet. | Haweswater Dam. | Normal Gravity Dam. | Ratio as per cent. |
|---|---|---|---|
| 40 | 24·6 | 27·2 | 90 |
| 60 | 47·4 | 56·7 | 84 |
| 80 | 73·5 | 96·8 | 76 |
| 100 | 102·0 | 148·0[1] | 69 |
| 120 | 133·5 | 209·0 | 64 |

[1] C. M. Saville quotes a figure of 170 in " Dam Construction " Trans. Inst. W.E

On the above basis the quantity of concrete for the whole dam is estimated to be 73 per cent. of the solid type, the percentage of cost being somewhat higher owing principally to the more elaborate formwork required for the buttress type.

### CONSTRUCTION

The methods to be adopted for the removal of the excavated material, and the subsequent deposition of concrete were decided after careful consideration of the pros and cons. Two systems of plant were suggested, namely overhead cableways or a series of large cranes ; of these the former were adopted as being the most suitable for the comparatively long dam to be constructed. Two 4-ton radial cableways of 1800ft. span were erected. Together with the remaining plant on the works they are operated by electric power, generated by three 300 H.P. Diesel engines.

The removal of the boulder clay overlying the site exposed a sound rock foundation at depths of zero to 40ft. The foundations are composed of andesite, a compact rock weighing 177 lb. per cubic foot, and having a crushing strength of 940 to 2300 tons per square foot. At the surface the rock was generally amply jointed, but exhibited little signs of weathering except at the few major joints. Fortunately, most of the joints were very fine, and were almost eliminated on subsequent excavation.

Most of the rock was removed by blasting, using two types of explosive, Gelamex No. 3 for the upper layers of rock, followed by Plastex, which is claimed to have local action, and therefore produces less disturbance to the final foundations beneath. Up to the present time, some 35,000 cubic yards of overburden and 41,000 cubic yards of rock have been excavated.

During the early stages of the work, the river was diverted from its normal bed across the site of the dam to a parallel channel cut in higher ground. A low earth bank was built across the existing river bed to keep the water from the excavations during floods. The lake (4·3 per cent. of the catchment area) provided an excellent accumulator during floods. As the channel invert was 5·5ft. below normal water level (694·5 O.D.) serious flooding of the site was not experienced. After excavation had been completed in the old river bed, and this portion of the dam (together with the main scour pipes) had been placed to sufficient height, two coffer dams were built at the ingress to and egress from the channel, and the water passed down the pipes. Dewatering of the site was maintained from sumps situated outside the dam profile.

Below the normal foundations, the cut-off trench was excavated to a minimum depth of 6ft. Staggered bore-holes 20ft. deep were drilled at 8ft. centres, and more often where the ground demanded, into the bottom of the trench for preliminary testing of the foundations. Pressures of 100 lbs. per square inch were used. If the pressures dropped rapidly, the trench was excavated further until final tests yielded less fissured rock. When sufficient depth of concrete was in place over the foundations, the holes were grouted with a slurry of cement and water of varying mix, according to their rate of absorption. Although pressures up to 200 lb. per square inch were used, each hole accepted very little cement, the maximum being 5 cwts. and the average about 1 cwt.

Immediately prior to concreting, the foundations were coated with a thin layer of " compo " (composed of one part cement to three of sand) in order to ensure a rich mix and good adhesion at the surface. The concrete was then placed by means of the overhead cableway, until the final level was reached, where transverse grooves were formed to assist the shear resistance of the horizontal joints. Brattice cloth placed above the concrete protected it from frost and drying winds. Rotary water sprays completed the curing of the horizontal surface until operations commenced on the succeeding layer, after an interval of at least seven days. Face curing continued for a further three weeks. Before placing the next layer, the set concrete was chipped with pneumatic tools and thoroughly cleaned. It had been the intention to remove this laitance by means of wire brushes, but they had no appreciable effect, even after 15 hours from deposition. When normal design section was attained, the progressive lifts were fixed at 4ft.

Timber shuttering erected on the rock foundations, and about 6in. outside of the normal plan section of the buttresses, formed the concrete for the first lift. After this concrete had set, standard unit shuttering was then erected to the correct lines and batter, ready for receiving the concrete for the normal 4ft. lift. This shuttering consisted of a number of panels so designed as to be used for successive lifts, a few interchangeable ones being utilised to accommodate for the progressive reduction in width of the dam. Each panel was faced with a steel plate 1/16in. thick (for contact with the concrete), backed by 1½in. timber with 3in. × 3in. angle iron walings, the whole being supported by 6in. × 3in. channel irons acting as cantilevers from the lower concrete. The channels were temporarily fixed to the lower concrete by means of two ¾in. diameter bolts threaded into nuts cast in this concrete at a depth of 8in. from the face. As the panels are of the heavy duty type, weighing 13·75 lb. per square foot, three hand-operated cranes fitted with cradles were provided for the work of stripping, lifting, and re-erection. Some of the panels have been used over 100 times and do not appear to show any appreciable need for repair.

A two cubic yard mixer (mixing 1·63 cubic yards) complete with weigh-batching plant, supplied all the concrete. It was situated close to the dam and was fed with aggregate from the stock heaps by a 5-ton derrick crane. Cement in 1 cwt. bags was stored in the building surrounding the plant. The ingredients were accurately controlled, and mixed for a minimum time of 2½ min. Buckets of 2 cubic yard capacity, each with a hand-operated roller gate at its base, were hauled from the mixer to either of the cableways for conveyance to the site.

A novel concrete distributor constructed of high tensile steel, and made to an outline design prepared by the technical staff engaged on the works, facilitated the delivery of concrete in thin layers over the whole area of two adjacent buttresses on consecutive days. This eliminated the laborious task of swinging the suspended bucket and hand-shovelling which normal methods entailed. The distributor consists principally of a belt conveyor enclosed by a lattice-work frame,

which can be operated to turn in a full circle and deliver concrete at radii of 12 to 35ft. A rectangular braced frame 33ft. by 18ft., standing on four legs, supports the conveyor, a hopper, and a platform. The full bucket is lowered on to the platform and its load discharged into the hopper which feeds the belt below. One man riding in the moveable frame controls the delivery of concrete. The machine rests on two adjacent buttresses and spans the chamber beneath. Steel tapered drums placed around each leg form holes in the concrete, which are later filled. The cableways convey the distributor in two parts from buttress to buttress as progress demands. Below 726ft. O.D., where the dam width exceeds 56ft., two distributors were used in parallel, each supplied by a cableway. Between this level and 754ft. O.D. (dam width 28ft.) they were used in series and covered four buttresses. Above 754ft. O.D. the dam width was considered insufficient to accommodate a distributor without risking the formation of cracks between the outer faces and their adjacent leg-holes. Further, the framework of the machine prevented the thorough compacting of the concrete at radii much less than the minimum. Moreover, the advantage to be gained by using them for such comparatively small quantities of concrete above this level was questionable. Hence resort was made to direct delivery of concrete from one cableway or both where possible.

The maximum fall of the concrete from the conveyor belt was generally 5ft. 6in., but this was exceeded when concrete was being placed in the foundations. On these occasions, the distributors rested on rock outcrops and concrete pillars. To overcome the tendency for segregation of the mix, the latter was passed through a vertical tapered tube of rectangular section, suspended from the delivery end of the conveyor frame. Vertical tubes of 4in. diameter up to 80ft. in length were also successfully used in placing the concrete of some of the footway piers inside the chambers of the dam. Delivery of concrete to the deeper portions of the cut-off trench was performed by the cableways direct, or with the assistance of a derrick crane. During the early months of concreting displacers were used where possible in the foundations, but as they seriously retarded the concrete cycle and caused increased instead of a decreased expenditure this practice was discontinued.

### PROGRESS

It was anticipated that peak output of concrete would be attained after about six months' progress, remain steady for a further year, and then tend to decrease as the level of the concrete approached the top of the dam. In order to extend the period of maximum progress, the available number of buttresses to be concreted were gradually increased, from six plus foundation work to fourteen, so that above a certain level two and later three lifts were concreted on the same day. Half the group of buttresses in progress usually proceeded one or more lifts ahead of the other half, so as to ensure, on their completion, minimum dislocation attendant on the removal of the shuttering panels to other groups of buttresses. The maximum output attained in one day was 275 cubic yards of concrete; in a week 1070 and in four weeks 3580. The average output to date is 615 cubic yards per week.

### CONCRETE MIX

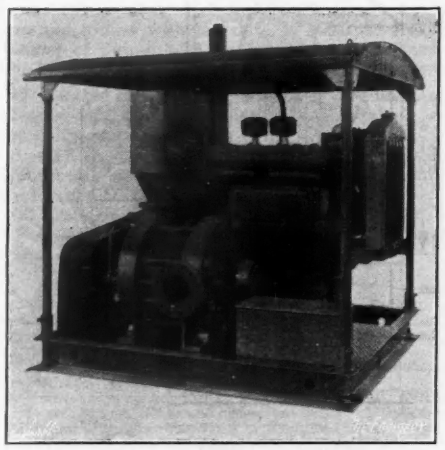
All the aggregates for concrete are crusher-run and obtained mainly from two sources, namely, the works quarry at Naddle Forest near the dam, and the Shap quarries about 6 miles distant. Both rocks are of igneous formation, the former a grey dolerite, the latter a pink granite. The dolerite after washing is crushed in ordinary jaw crushers, which produce a good shaped aggregate similar to the Shap product. Normal Portland cement is used throughout, low heat cement of the Swedish or American type not being available. Blast furnace cement, though having certain advantages over that used, was not seriously considered. Rapid hardening Portland cement was regarded as unsuitable because of its greater tendency to crack formation. Whilst determining the ideal mix it was borne in mind that strength was not the only property that mattered, but a compact and therefore impervious concrete was desired. This was only possible in practice by having a workable mix, which is more difficult to attain with leaner concrete, the controlling factor being the sand.

After numerous laboratory and field tests had been made, first working on the fineness modulus method of sand analysis, the final mix was eventually modified to 1 : 3·13 : 3·77 by weight (1 : 2·9 : 3·8 by volume assuming cement to weigh 90 lb. per cubic foot) with a water-cement ratio of 0·60 to 0·65 by weight. The resulting concrete weighed 152·75 lb. per cubic foot and had a cement content of 485 lb. per cubic yard. The mix, in departing from the traditional arbitrary ratio of sand to stone, has a high proportion of the former (¼-in. and down), which is essential for workability. Recent research appears to confirm the necessity of a high sand content when the aggregates are crusher-run. In practice, it was found that some variation in the sand grading of different days' deliveries was an important factor to be considered. This variation may be accounted for by the progressive wear and frequent replacement of crusher jaws. Fine sand, *i.e.* less than 0·006in. diameter, was not extracted from the sand in the belief that, although some strength is sacrificed, impermeability is improved.

The whole of the works were designed, and constructed by direct labour, under the direction of the Engineer for the Haweswater scheme, Mr. Holme Lewis, M.I.C.E., M.I. Mech. E., P.P. Inst. W.E.

## Transportable Emergency Pumping Sets for A.R.P. Service

IN the accompanying engravings, we illustrate an installation comprising three semi-portable emergency, oil-engine driven pumping sets, which have recently been put to work at the waterworks department of a leading industrial city. The units were supplied by John Fowler and Co. (Leeds), Ltd., and comprise a



PUMPING SET WITH CANOPY

six-cylinder Fowler-Sanders oil engine driving a Mather and Platt high-lift turbine pump, by means of V-ropes.

The principal purpose of the sets is to furnish an adequate emergency pumping installation, which can cope with a fire risk of the first magnitude. They have been installed in a new blast and splinter proof booster house, which has been specially designed for them. Our illustrations show the general appearance of one of the sets, and the arrangement of the three sets, coupled to the branches of the inflow and delivery mains which have been led into the station. In addition to being ready for instant service, the specification drawn up by the engineer called for completely transportable units, which can easily be transferred in order to meet an emergency elsewhere. The sets are thus completely self-contained and can be operated as individual units, suitable connections to the Corporation mains being provided. When used for outside work they are protected by a steel canopy, and will, we are informed, run without any specially prepared foundations.

As will be seen from the illustrations the engine and pump are mounted side by side on a bedplate built up from rolled steel channel sections, which forms a rigid unit of great strength. The overall dimensions of the frame are 7ft. 3in. by 6ft. 3in.

The engine is of the Fowler-Sanders 6D pattern, having six cylinders, with a bore of 4½in. and a stroke of 6½in. The rated output for continuous duty is 62·5 B.H.P. at 1140 r.p.m. By means of a hand-operated speed regulator, the running speed can be varied between plus 10 per cent. and minus 30 per cent. of the normal running speed. The engine is lubricated on the pressure feed principle, a pump driven by gears from the crankshaft being placed in the sump. The cooling of the engine is effected by means of a radiator and fan, the radiator being mounted offset from the front of the engine, and the fan driven by belt from the front end of the crankshaft. A centrifugal water pump, driven from the timing gear, circulates the cooling water. The fuel tank has a capacity of 34 gals. and is carried in a felt-lined cradle over the engine flywheel, which is supported by pressed steel side plates. For filling the tank from barrels at ground level, there is a semi-rotary hand-operated oil fuel transfer pump in the tank circuit. Careful attention has been paid to the dust-proofing of the engine, and all the working parts are enclosed and run in oil. The air inlets are furnished with "Handy" air cleaners, which work on the oil-wash principle.

The Mather and Platt pump is of the three-stage "Plurovane" type with a 7in. diameter suction branch and a 6in. diameter delivery branch. It has a designed output of 500 gals. per minute, when running at 1200 r.p.m. and delivering against a total head of 260ft.

From our first illustration it will be noted that the corners of the bedplate frame are provided with sockets into which tubular stanchions are fitted. They carry angle iron ribs, which in turn support a canopy made of heavy-gauge sheet steel. Should further protection be desired, a canvas curtain can be lowered from each edge of the canopy and held in position by quick release fasteners which are attached to the channel frame of the bedplate. The dismantling of the set for transport can be quickly effected. The sockets on the main frame and the angle iron ribs of the canopy are tapped to take locking bolts which secure the tubular stanchions. When these bolts have been slackened the canopy roof can be lifted off and the stanchions removed from their sockets. The general neat design of the sets will be seen in the engravings we reproduce. The weight of each set complete and ready for service is just under four tons.

## A New Industrial Heating Unit

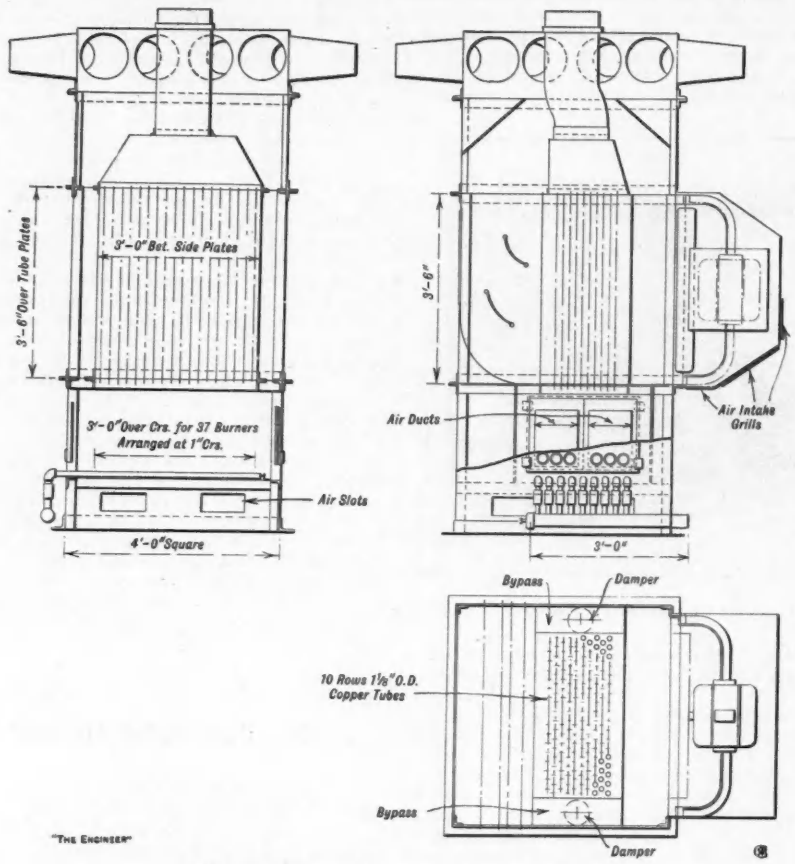
THE natural tendency for hot air to rise makes the economic heating of large open areas in industrial buildings, particularly those with high roofs, a matter of some difficulty with most heating stoves set at floor level. Such stoves usually warm the area immediately around and the hot air then rises to be wasted in the zone immediately below the roof. Thus the maintenance of an effective temperature of 60 deg. Fah. at a height of about six feet over a large working area generally necessitates the waste of a considerable amount of heat in the upper zones.

PUMPING SETS IN BOOSTER HOUSE

An interesting heating unit which maintains an even temperature in the lower working area without wasting heat in the roof levels has been designed by Vacuum Refrigeration, Ltd., of City Gate House, London, E.C.2. These heaters are of simple construction and design, their main feature being the method of distributing and maintaining a constant circulation of hot air over the lower, working areas of a floor. They are made for firing by coal, coke, gas, or oil, or where a supply of steam is available a

steam-air heat interchanger can be fitted. In addition to occupying a relatively small floor space in proportion to the area they heat, these units, it is claimed, do not require any extensive ducting for the transfer of heat and are rapidly and easily installed.

In the accompanying drawing is shown the arrangement of a standard gas heated unit. In this unit the hot gases from the burners pass up the inside of a nest of 175 copper tubes of a heat interchanger which occupies most of the chamber forming the central portion of the body. In order to prevent the formation of harmful moisture upon the tubes the burners are set to maintain a temperature of about 175 deg. or just above the point at which condensation occurs. The tubes terminate in a header which exhausts into a chimney passing through the top of the outer casing.




ARRANGEMENT OF INDUSTRIAL HEATING UNIT

Air is blown through the interchanger by a motor driven propeller fan set in one side of the heat interchanger compartment, and is directed upwards by curved deflector plates, across the width of the unit, at the rear of the tubes. The interchanger does not occupy the full width of the compartment and part of the air from the fan passes round each side. Air which is by-passed round the interchanger mingles with the heated air at the rear of the tubes and in an upper chamber formed round the tube header. This by-passing arrangement not only serves to break down what would otherwise be a somewhat excessive temperature at which to eject the heated air, but also cools down the sides of the heater casing to make unnecessary the lagging of the outside panels. Dampers on each side of the heat interchanger control the volume of air which is by-passed. By closing these dampers it is possible to pass practically the whole of the air through the heater and thus give an increased temperature to the outgoing air.

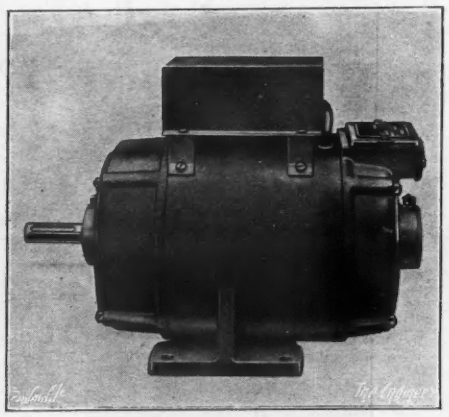
The heated air is distributed over the area to be warmed by a number of nozzles round the sides of the upper compartment of the unit. The temperature of the air is usually adjusted at 125 deg. and it has sufficient velocity to carry it a distance between 50ft. and 60ft. The nozzles are about 8ft. 6in. above floor level and the heated air from them is projected slightly downwards across the intervening space to the walls of the building where it is deflected down towards the floor. As the air passes across the space it diffuses downwards in a series of eddies and mixes with the air in the lower zones. In this way a continual circulation of heated air is maintained and recirculation is assisted to a certain extent by arranging the fan with its intake facing towards the floor.

In the gas type of heater a safety device is included by interlocking the fan switch with the gas pilot so that until the latter is lighted the fan cannot be switched on. All parts of the interior of the heaters are readily accessible for cleaning and inspection and they are easily adaptable for automatic thermostatic control.

## Fractional Horse-Power Single-Phase Motors

FOR industrial and domestic purposes small single phase motors usually take the form of split phase capacitor start or repulsion start motors. As a rule the essential difference between the three types is the relative values of the starting torque and current. Many applications require a much higher starting torque than the normal torque, and this is the reason for a number of machines being marketed, for an inherent fault of these motors is a relatively poor starting effort and a higher starting current as compared with those of three phase motors.

Of the three single phase machines mentioned, the split phase motor has the lowest starting torque and the highest starting current, although it is suitable for a large number of applications. Depending on the design and construction, the starting torque of these small machines varies between 60 and 200 per cent. of full load torque, with a starting current up to ten times the full load current, the figures varying not only with design and construction, but also with the horse powers and speeds.



FRACTIONAL HORSEPOWER MOTOR

The split phase capacitor start motor differs from the plain split phase machine in that it has a condenser in circuit during the starting period to increase the starting torque and in some cases it may remain in circuit during the running period, to improve the performance by raising the power factor and by promoting quicker running. Since a much smaller capacitance is required for running than for starting, the condenser is usually in two parts, an electrolytic portion which is in circuit during starting only, and a small paper insulated condenser in circuit during both starting and running continuously. The pull-in torque of a capacitor start and run machine is somewhat higher than that of a machine that uses a condenser for starting alone, although the static torque may be the same. Usually the starting torque of these machines is between 1½ and 3 times full load torque with from 3 to 5 times full load current.

When starting torques greater than those specified are needed, the repulsion start induction motor may be employed. This type of motor develops up to 5 times full load torque with 2 to 3 times full load current or in the case of some designs 3/3½ times full load torque, with only about twice full load current. This performance is much better than that of the two other types of motors described, but the machine is more complicated, is more expensive, and it is not quite so reliable in service. Split phase and split phase capacitor start motors are plain induction machines. The only movable part is a centrifugal switch which open-circuits when the machine has run up to full speed, the starting winding being "short time" rated usually at about 15 seconds. On capacitor start motors, the electrolytic condensers are usually designed for 40–60 one second starts per hour.

Repulsion start induction motors are more complicated than the two machines described for the reason that they have a wound armature with a commutator and brushgear. The more usual types also have centrifugally operated mechanism, which in addition to lifting the brushes from the commutator, also short circuits the commutator internally in order to change over from repulsion working at starting to induction working when running under normal conditions. When working under good conditions, a well designed motor of this kind will give little or no trouble and will only be subject to slight brush and commutator wear.

A fourth type of motor recently put on the market by Higgs Motors, Ltd., of Birmingham, combines the simplicity and reliability of the split phase machine with the performance of the repulsion start motor. Made in sizes up to 2 H.P. at 2800 r.p.m. and known as type "ETH," this split phase motor has a patented rotor which, in conjunction with a condenser, gives an exceptional performance. Capacitor start motors using the improved rotor are for applications where the maximum pull-in torque is not required, and capacitor start and run motors where maximum pull-in torque combined with quiet running are essential. The latter compares very favourably with the normal repulsion start induction motor, whilst the former gives a performance better than the normal capacitor start machine. Both types have an approximate starting torque of 250/350 per cent. of full load torque, but an important feature in connection with these new motors is the high torque maintained during the whole of the accelerating period and particularly the pull-in torque, which is the minimum torque exerted by the motor at the time when the centrifugal switch comes into operation. In the capacitor start type of machine, this is 170/225 per cent. of full load torque and in the capacitor start and run type 200/300 per cent. of full load torque, which is at least as good as that of the majority of repulsion start motors and better than quite a number of them. Since these new motors only have a small reliable condenser and a new robust centrifugal switch, the combination of a high starting torque and reliability is obtained in a simple way. There is believed to be a considerable field for these new machines in connection with the operation of refrigerators, compressors, milking machines, vacuum pumps, &c.

An example of one of the new machines is shown in the accompanying illustration.

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WHITE BRONZE.—The fourth issue of "Tin and Its Uses," the quarterly review issued by the International Tin Research and Development Council, announces a new "white-bronze" plating which, it is claimed, out-rivals chromium in its resistance to tarnish and is almost identical in colour and reflecting power to perfectly polished silver. Photographs are reproduced which illustrate the brilliance and other attractive qualities of this new finish on spoons, taps, metal tea-sets, and car fittings, and it is suggested that it will also find extensive applications in reflectors for optical instruments, headlamps, &c., unbreakable shaving mirrors, shop fittings, and many other ornamental metal wares.

HYDRO-ICECUTTERS.—It is reported that the icebreaker "Lenin" is to be fitted with a new hydro-icecutter for the purpose of testing out the device under practical conditions during March and April next. The principle on which the hydro-icecutter works is as follows:—Two or three powerful jets of water under high pressure (50 atms.) are played upon the surface of the ice from specially constructed monitors. These jets cut into the ice to a depth which considerably reduces its resistance. This eliminates the need for the icebreaker to cut a way through the ice by impact and permits her to move at the rate of 1 to 2 m.p.h. In 1937 experiments in the cutting of ice by a water jet under high pressure were carried out at the port of Leningrad. During these experiments ice of 31½in. in thickness was cut at the rate of 13ft. per minute with an apparatus of only 250 H.P. The icecutter to be installed on the "Lenin" is of 1500 H.P. This will permit an icebreaker to travel at a speed of 2 m.p.h. through ice 6½ft. thick. The apparatus, which consists of a very powerful engine and a pump, has already been completed and dispatched for installation. Should the experiments prove successful, all Soviet icebreakers will be fitted with the same equipment.

# Advance in Iron and Steel Prices

THE Control of Iron and Steel (No. 6) Order, 1940 (a), dated January 29th, 1940, has been issued, and is as follows :—

1.—(1) No person shall acquire or agree to acquire any material situate in the United Kingdom on or at any time after the date on which this Order comes into force and mentioned in the First Schedule hereto : except under the authority of a licence granted by the Minister of Supply, or in accordance with a special or general direction issued by the Minister of Supply.

(2) No person shall dispose of or agree to dispose of any material situate in the United Kingdom on or at any time after the date on which this Order comes into force and mentioned in the First Schedule hereto : except to a person who is authorised to acquire that material by virtue of a licence granted by the Minister of Supply, or by virtue of a special or general direction issued by the Minister of Supply.

(3) Nothing in this Article shall be taken to prohibit or restrict the delivery to and acceptance by a person carrying on the business of a carrier of any material mentioned in the First Schedule hereto in the ordinary course of that business, or the delivery by and acceptance from such a person of any such material in the ordinary course of that business.

2.—(1) No person shall buy or sell or offer or invite an offer to buy or sell for delivery in the United Kingdom any material situate in the United Kingdom on or at any time after the date on which this Order comes into force : except at a price which is either

(a) not in excess of the maximum price for material of that description in force under this Order at the time of such purchase or sale or agreement or offer or invitation of an offer to buy or sell ; or

(b) defined in such a way that it cannot exceed such maximum price for material of that description as may be in force under this Order at the time of delivery of such material.

(2) (a) For the purposes of this Article, the maximum price for material of any description in force under this Order at any time shall be ascertained from the Second Schedule hereto and the Related Schedules.

(b) The Second Schedule hereto and the Related Schedules may be varied, and further Related Schedules may be added to this Order, by special or general direction issued by the Minister of Supply.

(3) In the case of any material mentioned in the First Schedule hereto being material of a description for which no maximum price is in force under this Order, any person shall comply with any notice given (or special or general direction issued) by the Minister of Supply

(a) requiring that person not to sell or agree or offer to sell for delivery in the United Kingdom any such material at a price exceeding a maximum price to be fixed by the Minister of Supply for that material, or

(b) fixing the maximum price for that material.

3.—For the purposes of Articles 1 and 2 of this Order, material which is or is agreed to be acquired bought disposed of or sold, or which is the subject of an offer or invitation of an offer to buy or sell, shall be deemed to be situate in the United Kingdom on or at some time after the date on which this Order comes into force : unless it is proved that at the time at which it was or was agreed to be acquired bought disposed of or sold, or became the subject of an offer or invitation of an offer to buy or sell, it was situate outside the United Kingdom or was non-existent and was to come into existence outside the United Kingdom.

4.—Every person carrying on any undertaking which involves the production, treatment, keeping, storage, movement, transport, distribution, disposal, acquisition, use or consumption of any material mentioned in the First Schedule hereto shall, upon being requested so to do, either by notice given to him or by special or general direction issued by the Minister of Supply—

(a) keep such books, accounts, and records relating to that undertaking as may be specified in the request ;

(b) produce to any inspector or examiner appointed by the Minister of Supply such of the books, accounts and other documents relating to that undertaking as may be demanded by such inspector or examiner ;

(c) within such time as the Minister of Supply may direct, furnish to the Minister of Supply such estimates, returns and other information relating to that undertaking as the Minister of Supply may require ; and

(d) permit any inspector or examiner appointed by the Minister of Supply to enter and inspect, with a view to securing compliance with this Order, any premises used for or in connection with that undertaking.

5.—(1) The holder of any licence granted under this Order shall comply with any conditions contained in the licence.

(2) If any licence granted under this Order is revoked by the Minister of Supply the holder of the licence shall forthwith deliver up the licence as directed by the Minister of Supply.

6.—Nothing in this Order shall apply to any sale or purchase or other disposition of any material to or from the Minister of Supply or any agreement or offer so to sell buy or otherwise dispose of or acquire any material.

7.—(1) In this Order, the expression "Related Schedule" means any one of the related price schedules for iron and steel products lodged with the Minister of Supply for the purposes of this Order and certified as a "Control of Iron and Steel (No. 6) Order, 1940 : Related Schedule No.....", by the signature (dated with the date of certifying) of the Minister of Supply : the number of which Related Schedules at the coming into force of this Order is 84.

(2) In this Order the expressions "acquire" and "dispose of" include respectively the taking and giving of possession.

8.—(1) The Control of Iron and Steel (No. 4) Order, 1940, shall cease to have effect as from the coming into force of this Order.

(2) This Order shall come into force on the 1st day of February, 1940, and may be cited as the Control of Iron and Steel (No. 6) Order, 1940.

## THE FIRST SCHEDULE

1. Ore (excluding Iron Pyrites and Cupreous Pyrites, but including Pyrites ash and burnt Pyrites residues whether in briquetted or other form) containing not less than 15 per cent. of iron.

2. Manganese Ore ; Ore, concentrate or residue containing Tungsten, Molybdenum or Vanadium.

3. Ferro-Alloy of any kind, Molybdenum Metal, Calcium Molybdate, Molyte, bricks and briquetted forms of Molybdenum Dioxide and of Molybdenum Trioxide, Tungsten Metal, Tungsten Carbide, Cemented Carbide Hard Metal, Calcium Silicide.

4. Cinder and Scale produced during the manufacture or mechanical treatment of Iron and Steel.

5. Iron and Steel in any of the following forms :—

Pig ; Ingot ; Billet, bloom slab ; Tinplate bar, sheet bar ; Plate, medium plate, sheet (and whether coated or uncoated) ; Angle, channel, tee, joist, piling section, other sectional material (and whether fabricated or not) ; Round, rod, square, hexagon, flat, other section and shape (and whether black or bright) ; Rail, sleeper, fishplate, soleplate ; Tinplate, terne plate, black plate, silver-finished plate ; Hoop, strip (and whether coated or uncoated, and whether hot or cold rolled) ; Tube, pipe, and standard fittings therefor (and however made) ; Tyre, axle, wheel ; Casting, block for forging, block for pressing, forging, stamping, pressing ; Colliery Arch, and accessories therefor, pit prop ; Bolt, nut, screw stud, washer, rivet, screw ; Railway spring (and whether laminated or coiled) ; Bridge, pier, tank, plate and other structural steel work, in assembled or partly assembled form (and whether complete or incomplete) ; Wire Rod ; or Coated or uncoated wire, whether plain or barbed, wire rope, wire strand, wire netting, wire chain link fencing, wire mesh, wire nail, wire staple.

## THE SECOND SCHEDULE

### MAXIMUM UNITED KINGDOM PRICES FOR IRON AND STEEL PRODUCTS

Unless otherwise stated, prices set out or referred to in this Schedule, are basis prices per ton, for the quantity (if any) shewn, delivered to buyer. Other prices (related or additional) for products of the classes set out below, and extras allowances and rebates, shall be those provided for in or calculated in accordance with the Related Schedules.

| | £ s. d. |
|---|---|
| **IRON ORE—** | |
| All prices are f.o.t. at quarry or mine. | |
| (1) Hematite, for use in blast furnaces, mined in the counties of Cumberland, Lancashire and Glamorgan | 1 6 3 |
| (2) Hematite, lumpy, for use in steel furnaces | 2 2 0 |
| (3) Jurassic Ores, quarried or mined in the Frodingham district of Lincolnshire | 3 9 |
| (4) Jurassic Ores, quarried in Oxfordshire | 3 0 |
| (5) Jurassic Ores, quarried or mined in Leicestershire, Northamptonshire, Rutland or Lincolnshire (other than provided for under (3)) | 4 0 |
| (6) Calcined Ore, quarried in Oxfordshire | 7 0 |
| (7) Calcined Ore, quarried or mined in Leicestershire, Northamptonshire, Rutland or Lincolnshire | 8 6 |

**FERRO-ALLOYS AND ALLIED MATERIALS—**

| | |
|---|---|
| Ferro-Molybdenum and Molyte | 6s. 0d. per lb. of Molybdenum content. |
| Calcium Molybdate | 5s. 9d. per lb. of Molybdenum content. |
| Ferro-Tungsten 98/99 per cent. | 5s. 1d. per lb. of Tungsten content. |
| Tungsten Powder | 5s. 2½d. per lb. |
| Ferro-Vanadium | 15s. 6d. per lb. of Vanadium content. |

| | £ s. d. |
|---|---|
| **CINDER AND SCALE—** | |
| (a) Produced in the United Kingdom and delivered carriage paid at any iron or steel works in England or Wales :— | |
| Good Clean Scale | 1 7 6 |
| Ball Furnace Cinder containing not less than 68 per cent. iron | 1 7 6 |
| All other Cinder | 1 2 6 |
| (b) Produced and used in Scotland—f.o.t. producers' works :— | |
| Mill Cinder | 9 0 |
| Puddle Tap | 11 0 |
| Steel Cinder | 13 6 |
| Scrap Tap | 15 6 |
| Scale | 15 6 |

| | £ s. d. |
|---|---|
| **PIG IRON—** | |
| *Basic—* | |
| (a) South Wales, N.E. Coast, Scotland, Mersey Ports, Lancashire, Cheshire, N. Wales and North Staffs. | 5 4 6 |
| (b) Sheffield | 5 7 0 |
| (c) South Staffordshire | 5 9 6 |
| *Hematite.*—No. 1 Mixed Nos., S. & P. over 0·03 per cent. but not exceeding 0·05 per cent. :— | |
| (a) Scotland, N.E. Coast and West Coast of England | 6 7 6 |
| PIG IRON (*continued*)— | |
| (b) Sheffield | 6 13 0 |
| (c) Birmingham | 6 19 0 |
| (d) Wales—Welsh Iron | 6 3 0 |
| *Foundry and Forge—* | |
| (1) No. 3 Iron, Class 2— | |
| (a) Delivered Middlesbrough | 5 11 0 |
| (b) Delivered Birmingham | 5 13 0 |
| (2) Phosphorus 0·5 per cent. to 0·75 per cent.— Delivered Birmingham | 6 0 6 |
| (3) Phosphorus 0·1 per cent. to 0·5 per cent.— Delivered Birmingham | 6 9 0 |
| (4) Scotch Foundry Iron—Delivered in Scotland or England, f.o.t. producers' works | 5 12 6 |
| *Cylinder and Refined Irons—* | |
| (a) North Zone | 7 19 0 |
| (b) South Zone | 8 1 6 |
| *Cold Blast Pig Iron—* | |
| (a) South Staffordshire | 10 5 0 |
| FORGING INGOTS up to 0·60 per cent. C. | 11 0 6 |

| | £ s. d. |
|---|---|
| **BILLETS, BLOOMS AND SLABS FOR RE-ROLLING—** | |
| *Basic—* | |
| (a) Soft U.T. (100-ton lots) | 9 7 6 |
| (b) Soft T.G. up to 0·25 per cent. C. (100-ton lots) | 9 12 6 |
| (c) Hard, 0·42 per cent. to 0·60 per cent. | 10 10 0 |
| (d) Silico-manganese | 13 2 6 |
| (e) Free-cutting | 11 2 6 |
| *Siemens Martin Acid—* | |
| (a) Up to 0·25 per cent. C. | 12 7 6 |
| (b) Case Hardening | 13 5 0 |
| (c) Silico-manganese | 13 2 6 |

| | £ s. d. |
|---|---|
| **BILLETS, BLOOMS AND SLABS FOR FORGING AND STAMPING—** | |
| (a) Basic Soft, up to 0·25 per cent. C. | 11 0 0 |
| (b) Basic Hard, 0·42 per cent. to 0·60 per cent. C. | 11 7 6 |
| (c) Acid, up to 0·25 per cent. C. | 12 17 6 |
| (d) Acid Case Hardening | 13 15 0 |
| (e) Acid Silico-manganese | 13 12 6 |

**ALLOY STEELS—**

| | Nickel 0·6–1 per cent. | Nickel-Chrome Ni 2·75–3·75 Cr 0·6–1·25 per cent. | Nickel-Chrome-Molybdenum Ni 2·75–3·75 Cr 0·6–1·25 Mb 0·20–0·60, per cent. |
|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. |
| Billets, 2in. up to and including 10in. | 16 2 6 | 27 17 0 | 34 13 0 |
| Stamping Bars, 2in. diam. and up, round or equivalent sectional area | 22 3 0 | 35 4 6 | 43 3 6 |

**HIGH SPEED STEEL—**

| | 14 per cent. Tungsten Per lb. | 18 per cent. Tungsten Per lb. | 22 per cent. Tungsten Per lb. |
|---|---|---|---|
| | s. d. | s. d. | s. d. |
| Bars | 3 0 | 3 10 | 4 4 |

| | £ s. d. |
|---|---|
| **TINPLATE AND SHEET BARS—** | |
| Not less than 25 tons of one width and quality, 9 lb. and over per ft. for bars under 8in. down to 18 lb. and over for bars 14in. and over | 9 5 0 |

**WIRE RODS—**

| | £ s. d. |
|---|---|
| *Basic.*—All sizes with exception of over 7/0 gauge and 6 gauge delivered in all districts in United Kingdom except (a) Birmingham and Scotland, and (b) Southern Joint Area :— | |
| Soft Basic 0·08 per cent. to 0·25 per cent. C. | 13 15 6 |
| Hard Basic, 0·42 per cent. to 0·60 per cent. C. | 16 18 0 |
| Free-cutting | 15 18 0 |
| *Acid.*—Up to 0·85 per cent. C. all sizes with exceptions of over 7/0 gauge and 6 gauge, delivered all districts :— | |
| Ordinary | 20 9 0 |

**MANUFACTURED IRON—**

| | Crown Iron | No. 3 Bars | No. 4 Bars |
|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. |
| (a) English and Welsh delivery, usual districts | 12 17 6 | 11 7 6 | 11 17 6 |
| (b) Scottish delivery, usual districts | 12 17 6 | 12 10 0 | 12 15 0 |
| (c) Irish delivery, f.o.q., Belfast | 13 10 0 | 12 0 0 | 12 10 0 |

**HEAVY STEEL PRODUCTS—**

| | Joists and Angles | Plates | Boiler Plates |
|---|---|---|---|
| Deliveries to the following Principal Districts :— | £ s. d. | £ s. d. | £ s. d. |
| (a) North-east Coast, Northern Joint Area, Scotland, Belfast shipyards and shipbuilders at Thorne, New Holland and Gainsborough | 12 8 0 | 12 10 6 | 13 8 0 |
| (b) Leeds and District, Midland Area and and South Wales | 12 8 0 | 12 13 0 | 13 10 6 |
| (c) Southern Joint Area | 12 10 6 | 12 15 6 | 13 13 0 |
| *Medium Plates* (under $\frac{3}{16}$in. thick) all deliveries :— | | | |
| Weighing 6 lb. or more per sq. ft. | — | 14 0 0 | — |
| Weighing less than 6 lb. but not less than 4·81 lb. per sq. ft. | — | 14 10 0 | — |
| *Chequered Plates* (¼in. thick and upwards) delivered to :— | | | |
| (a) North-east Coast and shipbuilders at Thorne, New Holland and Gainsborough | — | 14 0 6 | — |
| (b) Northern Joint Area, Scotland, Leeds and District, Midlands and South Wales, Southern Joint Area | — | 14 3 0 | — |

| | £ s. d. |
|---|---|
| **RAILS—** | |
| *Heavy Rails.*—60 lb. per yard and over, lots of 500 tons and over ; f.o.t. Maker's works | 11 3 0 |
| *Light Rails.*—Light flange rails, up to and including 25 lb. per yard | 13 6 6 |

| | £ | s. | d. |
|---|---|---|---|
| **COLLIERY ARCHES AND ACCESSORIES—** | | | |
| 4 by 2½ by 2 and 4 by 2½ by 2½, single radius with straight horseshoe, or splayed legs with one fishplate joint, complete with one pair of fishplates and the necessary bolts and nuts ... ... | 13 | 12 | 6 |
| *Arches* as above but *without* fishplates, bolts and nuts... ... ... ... ... ... ... ... ... ... | 13 | 10 | 0 |
| *Fishplates* (for Arches) alone ... ... ... ... ... | 19 | 0 | 0 |
| *Plain Cambered Girders*, 4 by 2½ by 2 and 4 by 2½ by 2½ with minimum camber of 2in. in centre, for use underground only ... ... ... ... ... | 13 | 5 | 0 |
| Corrugated Straps, Roofing, or Benk Bars ... ... | 12 | 12 | 6 |
| **RE-ROLLED STEEL PRODUCTS—** | | | |
| *Angles and Tees* 4 united inches and under, and *Channels* 3in. web and under: Basis U.T. ... ... ... ... ... ... ... ... | 13 | 10 | 0 |
| *Bars—Flats* 5in. wide and under and *Rounds and Squares* under 3in. U.T. ... ... ... ... ... | 14 | 0 | 0 |
| *Free-cutting Bars—Rounds* ... ... ... ... ... | 15 | 12 | 0 |
| *Hoop and Strip*—hot rolled (excluding hoop and strip for Gas, Steam and Water Tubes) U.T. ... | 14 | 15 | 0 |
| *Hoop and Strip*—cold rolled basis. Hard Bright—in coils (not annealed)—1½in. to 6in. by 0·032in. and thicker ... ... ... | 21 | 16 | 0 |
| *Products made from Basic Hard Steel*—0·42 per cent. to 0·60 per cent. C. ... ... ... | 15 | 0 | 6 |
| *Products made from Siemens Martin Acid Steel*—Up to 0·25 per cent. C. ... ... ... ... ... | 16 | 18 | 0 |
| *Spring Steel Bars*— | | | |
| Laminated— | | | |
| (*a*) Basic 0·42 to 0·60 per cent. C. Water Hardening ... ... ... ... ... ... ... | 15 | 0 | 6 |
| (*b*) Acid 0·42 to 0·60 per cent. C. Water Hardening ... ... ... ... ... ... ... | 18 | 11 | 6 |
| *Siemens Martin File Steel*— | | | |
| Long lengths 12in. and up— | | | |
| (*a*) Acid ... ... ... ... ... ... ... ... | 20 | 3 | 0 |
| (*b*) Basic ... ... ... ... ... ... ... ... | 17 | 10 | 0 |
| *Ferro-concrete Bars*—delivered station or siding ... | 13 | 7 | 6 |
| *Rivet, Bolt and Nut Bars* (4 ton lots) ... ... ... | 14 | 3 | 0 |
| **BRIGHT DRAWN STEEL BARS—** | | | |
| (*a*) Mild Steel to no analysis or tests ... ... ... | 19 | 15 | 0 |
| (*b*) Tested and guaranteed, 28 tons to 32 tons tensile ... ... ... ... ... ... ... ... | 20 | 15 | 0 |
| (*c*) Free-cutting, B.S.S. 32, Grade 4 ... ... ... | 21 | 11 | 6 |
| **SHEETS—** | | | |
| (*a*) Black, 24 G.—4 tons and over of basis quality | 17 | 10 | 6 |
| (*b*) Galvanised, corrugated, 24 G.—4 tons and over of basis quality ... ... ... ... ... ... | 20 | 0 | 0 |
| **TINPLATE—** | | | |
| Coke quality per basis box (I.C. 20 by 14—112 sheets—108 lb.), f.o.t. Maker's Works ... ... | 1 | 4 | 9 |
| **TUBES AND PIPES—** | | | |
| *Steel Gas Tubes* to B.S.S. 789—⅛in. to 6in. diameter. The gross price per ft. stated in the British Standard Gas list less 58½ per cent. for sales by Makers. | | | |
| *Steel Tubes* to B.S.S. 534—Table 1, Class A nominal size 10in., outside diameter 10¼in. ... ... 5s. 2d. per ft. | | | |
| *Spun Iron Pipe* 6in. diameter to B.S.S. Class B delivered station London in 4 ton lots and over 7s. 10½d. per yd. | | | |
| **WIRE—** | | | |
| *Mild Steel Wire.*—Catch weight coils 6/8 standard wire gauge: | £ | s. | d. |
| Hard drawn ... ... ... ... ... ... ... ... | 18 | 0 | 0 |
| Mild drawn ... ... ... ... ... ... ... ... | 19 | 10 | 0 |
| Annealed ... ... ... ... ... ... ... ... | 19 | 10 | 0 |
| *Galvanised Barbed Wire.*—2 or 4 point, 2 ply, 12½ gauge ... ... ... ... ... ... ... ... | 26 | 0 | 0 |
| **FORGINGS—** Prices set out in the Related Schedules plus the percentage additions in operation at November 1st, 1939, plus a further 6 per cent. | | | |
| **STEEL CASTINGS—** Prices set out in the Related Schedules plus 13s. 4d. per ton. | | | |
| **TYRES, AXLES, AND SOLID WHEELS—** Prices set out in the Related Schedules plus 25s. per ton. | | | |
| **RAILWAY COIL SPRINGS—** Prices set out in the Related Schedules plus 28s. per ton. | | | |
| **LAMINATED RAILWAY SPRINGS** Prices set out in the Related Schedules plus 30s. per ton. | | | |
| **IRON CASTINGS WHICH HAVE NOT BEEN SUBJECTED TO ANY PROCESS OTHER THAN MOULDING, FETTLING, ANNEALING OR PAINTING—** The seller's latest price ruling in 1939 before 1st September, 1939, with the addition of 8 per cent. plus 13s. 4d. per ton or an equivalent percentage and any appropriate extras set out in the Related Schedules for alloy additions. | | | |

## CONTROL OF IRON AND STEEL (NO. 6) ORDER, 1940, DIRECTION (NO. 1).

1.—Notwithstanding anything in paragraph (1) of Article 1 of the Order—

(*a*) Iron Ore Mined or quarried in the United Kingdom, Pyrites ash and burnt Pyrites residues;

(*b*) Manganese Ore for the purpose of manufacturing any Chemicals, Electric Batteries, Manganese Metal, Glass or Ceramics;

(*c*) Tanks and cylinders of which every sheet or plate is under $\frac{5}{16}$in. thickness;

(*d*) Iron castings which have been subjected to any process other than moulding, fettling, annealing or painting;

(*e*) Boot and shoe grindery;

may until further notice be acquired in the United Kingdom without licence.

2.—Notwithstanding anything in paragraph (1) of Article 1 of the Order, any material (other than (i) pig iron and (ii) High Speed Steel containing 14 per cent. or more of Tungsten) included in the First Schedule to the Order may until further notice be acquired without licence:—

(*a*) by any Government Department—for any purpose;

(ii) by any person having a contract with a Government Department or a sub-contract under such a contract—for use by that person directly in the fulfilment of that contract or sub-contract;

(*b*) (i) by the following undertakings or persons for the execution in the United Kingdom of the purposes stated in respect of them; that is to say:—

any person—for the purpose of fulfilling an obligation imposed on that person by the Civil Defence Act, 1939 for Air Raid Precautions;

any railway undertaking under the control of the Minister of Transport by virtue of any Order made under the Defence (General) Regulations, 1939—for the purposes of that undertaking;

any electricity generating station generating for public supply—for the purposes of that station;

any public utility undertaking within the meaning of Regulation 100 of the Defence (General) Regulations, 1939, and not before mentioned in this paragraph—for repair work and maintenance work for the purposes of that undertaking;

any shipbuilder, ship-repairer, marine engineer, or marine boilermaker—for the building, repairing or equipment of any ship; shipowner—for the repair or maintenance of any ship;

mine or quarry undertaking—for mining or quarrying in any mine or quarry of that undertaking;

agricultural machinery or implement maker or repairer—for making or repairing any agricultural machinery or implement for use in the United Kingdom;

locomotive builder or repairer—for building or repairing any locomotive for use in the United Kingdom;

wagon builder or repairer—for building or repairing any railway wagon for use in the United Kingdom;

iron or steel works or foundry or forge—for repair or maintenance thereof; and producer of refractory material—for repair or maintenance of any Refractory Works owned or operated by him.

(ii) by any person having a contract with an undertaking or person mentioned in sub-head (i) of this head (*b*) or a sub-contract under such a contract—for use by that person directly in fulfilment of that contract or sub-contract;

Provided that nothing in this head of this paragraph shall authorise a stockholding merchant to acquire for stock, any material included in the First Schedule to the Order;

(*c*) by any person making a purchase of any material (other than (i) pig iron and (ii) High Speed Steel containing 14 per cent. or more of Tungsten) included in the First Schedule to the Order from the stock actually held at the time of such purchase by a stockholding merchant—for use in the United Kingdom; and

(*d*) by any person making purchases of any material included in any one of the following categories not exceeding the quantity specified against each category nor £10 in value (further purchases of material in such category not being permitted in the same calendar week)—for the execution in the United Kingdom of any purpose:—

| Category | Description | Quantity |
|---|---|---|
| (i) | Ferro-alloy of any kind ... ... ... | 5 cwt. |
| (ii) | Calcium Molybdate ... ... ... ... | 56 lbs. |
| (iii) | Molyte ... ... ... ... ... ... ... | 56 lbs. |
| (iv) | Tungsten metal ... ... ... ... ... | 56 lbs. |
| (v) | Tungsten carbide ... ... ... ... ... | 10 lbs. |
| (vi) | Cemented carbide hard metal ... ... | 2 lbs. |
| (vii) | Calcium silicide ... ... ... ... ... | 5 cwt. |
| (viii) | Tinplate ... ... ... ... ... ... ... | 6 cwt. or 3 double boxes |
| (ix) | Terne plate ... ... ... ... ... ... | 6 cwt. or 3 double boxes |
| (x) | Black plate ... ... ... ... ... ... | 5 cwt. |
| (xi) | Silver-finished plate ... ... ... ... | 5 cwt. |
| (xii) | Iron casting ... ... ... ... ... ... | 5 cwt. |
| (xiii) | Bolt, nut, screw stud, washer ... ... | 5 cwt. |
| (xiv) | Rivet ... ... ... ... ... ... ... | 5 cwt. |
| (xv) | Screw ... ... ... ... ... ... ... | 5 cwt. |
| (xvi) | Bridge, pier, tank, plate, and other structural steel work, in assembled or partly assembled form (and whether complete or incomplete) ... ... ... | 5 cwt. |

3.—This Direction shall come into force on the 1st day of February, 1940, and may be cited as the Control of Iron and Steel (No. 6) Order, 1940, Direction (No. 1).

### EXPLANATORY MEMORANDUM

The Control of Iron and Steel (No. 6) Order, 1940, supersedes the Control of Iron and Steel (No. 4) Order, 1939 (S. R. & O. 1939, No. 1533).

Attention is called to the following differences between the old and new Orders.

1. *The First Schedule.* The word "spike" has been deleted and the words "screw stud" have been added.

2. *The Second Schedule.* The maximum prices have been revised.

3. *Direction* (*No.* 1). Heads (*a*) and (*b*) of Paragraph 2 have been revised in order to clarify the existing position in regard to contractors and sub-contractors of the exempted persons specifically named. A contractor or sub-contractor can acquire material without licence only for the express purpose of using such material directly in fulfilment of a contract with an exempted principal or of a sub-contract under such a contract.

In sub-Head (*b*) (*i*) the exemption from licence of purchases of material required for Air Raid Precautions has been limited to purchases of material required to enable the purchases to fulfil an obligation under the Civil Defence Act, 1939.

Under Head (*c*) a retailer who carried a stock will be regarded as a Stock-holding Merchant.

In Head (*d*) the list of materials which may be purchased without licence in small quantities has been drastically revised and curtailed and particular attention is drawn to this revision. This, of course, does not preclude purchasers of small lots buying where available from stock under Head (*c*).

## BRITISH STANDARDS INSTITUTION

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.*

### STREET LIGHTING UNDER WARTIME CONDITIONS

(B.S./A.R.P. 37).—The aim of the Specification, and in fact of any well-designed street lighting scheme, is to obtain as even an illumination as practicable. It is, of course, impossible to achieve complete uniformity, but the general level of illumination, if the Specification is complied with, will approach closely to 0·0002 foot-candle and will nowhere exceed 0·004 foot-candle.

To achieve this result three main considerations apply, namely:—

(*a*) The candle-power distribution from the lighting fittings.

(*b*) The height at which the fittings are mounted.

(*c*) The spacing of the lighting columns.

These three items are inter-related. The first is the concern of the manufacturer of the fittings, while the second and third are more or less determined by the present disposition of the existing columns. To meet practically all possible conditions of mounting height and spacing, three candle-power distributions have been standardised, and the manufacturers of the fittings are given a free hand to adopt any form of design they like provided that the light emitted is of an intensity and in a direction such that the polar curve of light distribution falls within the limits laid down in the Specification. It is considered that by allowing, in this way, each manufacturer to evolve his own design to suit his particular production facilities, the placing of suitable fittings on the market will be expedited more than would be the case if all manufacturers had to adapt their tools for the production of a rigidly standardised design. At the same time steps must be taken to see that this freedom is not abused by the production of fittings which do not strictly conform to the Specification. When it is realised that a single light might be sufficient to enable a raiding aircraft to ascertain its position, it will be appreciated that street-lighting must be under rigorous control and that, in the first place, this control must apply to the production of suitable fittings. It is therefore an essential feature of the Specification that the fittings must bear the certification mark registered by the British Standards Institution. This mark may only be used by those to whom licenses have been granted by the B.S.I., and licensees are required to maintain strict control over their production to ensure that every marked fitting is in conformity with the approved sample.

The licensing scheme applies also to Lighting Authorities who may desire to adapt or convert their existing lanterns so as to bring them into conformity with the Specification. An approved and certified fitting, however, will not in itself provide a satisfactory lighting installation. The fittings must be mounted at the proper heights on columns correctly spaced. The Specification gives instructions regarding the ranges of mounting heights and spacings for which the standard fittings are suitable, and these must be strictly followed. Copies of this Specification (B.S./A.R.P. 37) may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 6d. (post free 8d.).

### ADDENDUM TO BRITISH STANDARD GLOSSARY OF TERMS USED IN ELECTRICAL ENGINEERING

(C.F. 4420).—The British Standards Institution has recently issued an addendum to the British Standard Glossary of Terms used in Electrical Engineering (No. 205—1936). The Addendum takes the form of a section dealing with terms and definitions used in radio-direction finding. These terms and definitions were published as a British Standard, with the approval of the appropriate B.S.I. Committees, at the request of the Department of Scientific and Industrial Research and were prepared by the Direction-finding Committee of the Radio Research Board, of that Department. They will be included in the body of the Glossary when that publication is revised. Copies of this Addendum can be obtained from the British Standards Institution, Publications Department, 28, Victoria Street, London, S.W.1, price 1s. each (1s. 2d. post free).

INDOOR FLYING TRAINING.—Hitherto the Link trainer apparatus has only been used for giving instructions in "blind" flying, but with new improvements and additions it can be used for visual or unhooded flying training on the ground. By the new method the dummy fuselage is set up in a large circular chamber on the walls of which is reproduced a cyclorama of various views such as countryside, clouds, mist conditions, seascape, towns, &c. The horizon of the landscape is correctly placed in relation to the nose of the Link and a pupil learns to fly the machine with reference to the various type of scene depicted. Driven by powerful bellows, the fuselage is steered on its turntable through all the motions of actual flight.

# Markets, Notes and News

**The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer.**

### The Continental Steel Trade

Some improvement is noticeable in the situation of the Continental iron and steel trades from the chaotic conditions which existed during the period from the outbreak of war practically until the end of 1939. In France most of the production is going into consumption by the munitions makers, but a certain amount of iron and steel seems available for commercial purposes. Prices have advanced considerably since the end of last August, but the rates now ruling were fixed by the Price Control Board on December 15th and for the time being it does not seem probable that they will be altered. At any rate the Comptoir Siderurgique de France has gone to the trouble of issuing long lists of basis prices and extras so that consumers of all categories may know how they stand with regard to the official quotations. In Belgium the market position has been improved by the allocation to the export trade of certain tonnages by Cosibel, the export organisation of the Belgian works. The quantities which have been made available are comparatively small and reflect the heavy home trade requirements for defence purposes and the low production. On the other hand there has been a distinct falling off in the volume of enquiry from overseas markets. The Belgian makers, however, say that this is more than counterbalanced by the heavy demand from Scandinavian countries, Switzerland, and Mediterranean markets. It is said that buyers in these countries are prepared to pay almost any price offered and that this accounts for the high levels at which Belgian and Luxemburg export prices are maintained. On the other hand considerable apprehension is expressed lest American exporters secure a footing in markets with which they have not hitherto done an extensive trade and from which it may be difficult to dislodge them in more normal conditions. Most of the export business in the circumstances now ruling has been done in merchant bars, but American competition in plates and sheets has been severely felt and the prices at which this material has been offered by the Americans has been well below the Belgian quotation. Some observers profess to see a tendency for Belgian and Luxemburg quotations to become easier, but they remain well above the level which many overseas buyers are prepared to pay. The reluctance of the Belgian and Luxemburg makers to sell in anything but francs or dollars is also a difficulty in the way of transacting business. The scarcity of fuel in Belgium is expected to be relieved shortly by the resumption of imports of German coal and coke, and it is reported that the Germans in return are anxious to place orders for locomotives. This is a reflection of the serious transport difficulties which exist in the Reich.

### The Pig Iron Market

The chief event in the pig iron market has been the increase in prices. It was expected that quotations would be raised, as costs have advanced. The explanatory notes, however, issued with the Order stated that the price additions were for the purpose of meeting from a central fund the additional costs, including higher freight charges, which arise from importations of raw and semi-finished materials under war conditions. The advance in the prices of pig iron of British manufacture amount to 3s. per ton and this is generally regarded as moderate. It is known, of course, that considerable tonnages will be brought from foreign countries, including additional quantities from India, which has supplied Great Britain with a regular tonnage of basic and foundry pig iron for a number of years. The advance in the price is unlikely to affect the demand for steelmaking irons, since practically the whole output is absorbed in the manufacture of products intended for use in Government work. The call for foundry iron has been irregular, largely because of the poor requirements of the light castings makers caused by the slackness in the building trades. In this department the increase of 3s. may have some influence upon trade since it will, of course, be reflected in the price of the finished article. On the North-East Coast no Cleveland iron is now being made and the stocks at the furnaces have become almost exhausted. As a consequence there is an increased demand from this district for Midland iron. Consumers are becoming accustomed to this state of affairs and so far there have been no complaints from firms engaged on national work regarding inability to obtain supplies. It is expected that another furnace will be put into operation in this district during the next week or two and will probably be devoted to the production of basic iron. In the Midlands the request for foundry iron is chiefly for low phosphoric quality from the engineering concerns employed upon war work. After war requirements have been met there is no surplus and it is expected that efforts will be made to increase the output of this description. The demand for high phosphoric foundry iron appears to be growing, and as a fair proportion of the light castings makers are now engaged upon Government orders it is possible that the demand will further expand. In Scotland the irregularity in business in foundry iron is more noticeable and few of the light castings makers are fully employed. Business in hematite iron is at a high level and consideration is being given to an increase in production, which at the moment is less than the demand. Considerable quantities are going into consumption at the steelworks and the engineering shops, and so far as can be seen the requirements of the consuming trade will continue to increase.

### The Midlands and South Wales

Apart from the advance in the official maximum prices there has been no change in the conditions ruling in the iron and steel markets in the Midlands. The increases did not make much impression upon any section of the trade, since they had been anticipated for several weeks and in the present state of the demand consumers are more concerned with deliveries than with prices. Satisfaction is expressed at the policy of meeting from a central fund the additional costs, including higher freight charges, which arise from importations of raw and semi-finished materials under war conditions. In some branches of the consuming industries the view is expressed that finished steel also should be imported in order to relieve the heavy pressure upon the British works and to avoid the possibility of their becoming greatly in arrears with deliveries. As it is, the works are experiencing unrelenting pressure from consumers of all kinds most of whom are engaged upon Government work and are anxious in many cases not only to secure prompt delivery but to accelerate the despatch of material against orders already placed. So great is the pressure that in a number of instances producers are declining to accept new business except for indefinite delivery, and the buyers are prepared to place orders on these terms in the hope that the works will execute their orders strictly in rotation. The demand is particularly insistent for structural steel of all classes and sizes and large tonnages are passing to the constructional engineers in spite of the seasonal slackening in operations in this industry. The quantities of steel being absorbed by the shipyards are equally large and the demand from this direction is expected to expand as time goes on, particularly now that the Admiralty has taken over the organisation of new merchant ship construction. The re-rollers suffered some interruption to supplies in January but are now receiving good quantities of billets and sheet bars and the position in this industry has materially improved. Practically all the works have sufficient orders to keep them busy for several months and if as is expected supplies of billets are well maintained the arrears which occurred as a result of the stringency in the supplies during November and December should be considerably reduced. The busy conditions which have characterised the South Wales steel trade for several months show no signs of slackening. The finishing branches are concerned with the stringency in the supply of steel and are looking forward to increased imports to relieve the position. The heavy export demand for tinplates has slackened somewhat but the makers have orders for about ten and a quarter million boxes on their books and are meeting a strong home trade demand. The increase in prices to 24s. 9d. is not regarded as excessive and compares with a figure of 32s. for export, f.o.b. 20 by 14 basis.

### The North East Coast and Yorkshire

The inability of some of the makers to accept new orders has given the market a rather quiet appearance. Consumers would be only too glad to place business against the contracts they hold, but it is practically impossible to find a works on this coast which has not sufficient orders on the books to ensure full employment for several months. Production is being pressed to the utmost and is at a high level. The supply of imported semis has considerably increased of late and it is understood that there are large quantities still to arrive. This has enabled the re-rolling works in this district to overtake some of their arrears in deliveries. The outlook in this section of the industry is especially favourable since the works have sufficient orders in hand to keep them occupied for a long time. The steelworks are engaged on the production of huge tonnages of angles, joists, and sections, all of which go into immediate consumption. The constructional engineers so far as can be seen will be busy for the remainder of this year and are pressing to secure supplies. Large tonnages are also passing to the shipyards, which are now fully employed. The increase in prices did not provide any surprise for the market. Joists, angles, and boiler plates were advanced £1 and medium plates and sheets by £1 7s. 6d., whilst light and heavy rails, colliery arches and accessories were also raised by £1. The sheet mills in this district are operating at capacity upon home orders but are also able to devote a certain amount of attention to the working off of old export contracts. In this department an advance of £1 7s. 6d. was made. Conditions in the Yorkshire market are much the same as in other districts. The works are operating at full capacity and are straining every nerve to keep up with the demand from consumers. There is, however, a tendency for the makers to fall into arrears in deliveries, particularly in the basic steel section. The pressure from consumers to obtain supplies of soft basic billets is severe, but some relief has been afforded lately by the distribution of a good tonnage of imported semis. Business in acid carbon billets is also increasing and the demand is now in excess of the supply. The increase in the case of billets and sheet bars was £1, which is not regarded as an exorbitant rise. The demand for bright drawn steel bars and special steels is steadily growing.

### Copper and Tin

The demand for copper in Great Britain is fully maintained but abroad business seems to have dwindled very considerably. The requirements of the British munitions industry is absorbing large tonnages but supplies appear to be reaching the works on a satisfactory scale. During the severe weather in January there were a certain number of unavoidable delays in transport, but these are being rapidly overtaken. The supplies of Empire metal are arriving with regularity and there is apparently no case of works being handicapped by a shortage of metal, although now and again complaints are heard that brands of copper are delivered to the use of which the particular works is not accustomed. In the world market prices have a definitely easy tendency, and reports from the United States say that the demand is negligible. American manufacturers of finished copper articles are said to be over-stocked although quantities well above the normal are passing into consumption The recent reduction in the price has failed to bring out any fresh buying and it is suggested that the stocks of copper now in hand and contracted for by the American consuming industries amount to between 60,000 tons and 70,000 tons above their known requirements. American exports of copper in December reached 49,921 tons, of which Japan took 15,035 tons, Russia 15,230 tons, France 9684 tons, Italy 1348 tons, and Switzerland 1628 tons. It is interesting to note that France is developing her domestic copper deposits and has opened the Closis Copper Mine, which is situated in the Alps at an altitude of 8000ft. . . . The tone of the tin market has been irregular for the past week or two and towards the end of last week there was a noticeable absence of any buying pressure. The removal of the prohibition upon the exports of tin is not being followed by any rush of buying from overseas users. It was expected that America would enter the market on a fairly large scale, but in actual fact users there have shown little interest. Some surprise has been occasioned by the quantities of tin exported from the United States during January, the total it is reported being about 2000 tons. In normal times the American exports are insignificant. The Army and Navy Munitions Board is understood to have called the attention of American dealers to this and has expressed concern at the unusually large re-exports of tin. Mr. W. H. Gartsen's statistics for January give the visible supply as 24,798 tons compared with 25,020 tons in December. The supplies last month were 18,022 tons, against 13,057 tons in the previous month and the deliveries 18,244 tons against 16,356 tons in December. American deliveries in January were 9780 tons compared with 11,366 tons in the previous month, whilst the deliveries to Great Britain totalled 1200 tons compared with 1055 tons in December.

### Lead and Spelter

The situation in the lead market is unchanged, but the Control appears to be supplying munition makers with all they require. There does not, however, seem to be any surplus for ordinary commercial users, and in some instances they are being placed in a difficult position. Enquiries on export account also are not often filled although apparently export licences are obtainable for certain manufactured lead materials. In the world market the recent reduction in the price does not appear to have stimulated active buying. Consumers are well provided for and are showing comparatively little interest in the market. It is difficult to assess the real world price of lead since quotations vary considerably in neutral countries. . . . The demand for spelter by British firms engaged in Government work appears to be increasing rather than the reverse. The large tonnages required, however, are freely available from the Control although naturally applications for licenses are carefully scrutinised. In view of the heavy demand it is not surprising that little metal seems available for commercial purposes, but on the other hand there does not appear to be a pressing demand for anything but war needs. The supplies are well maintained, and it is only in cases of certain brands that there is any shortage. Foreign G.O.B. spelter has not been imported since the commencement of the war and of course is now scarce, all the supplies reaching this country being from Empire sources. According to some reports also the supply of high-grade spelter is barely sufficient to meet the demand, and as a consequence its distribution is being carefully regulated. Ordinary G.O.B. metal, however, is freely obtainable.

### Non-Ferrous Metal Prices

The London Metal Exchange official average prices for January, which are still restricted to tin, show that during the month the price for cash metal declined by £8 4s. 7d., whilst three months was £7 9s. 7d. lower, and the settlement quotation £8 4s. 4d. below the average for December. The decline in values in this market can be principally attributed to the removal of the restriction on the production of tin, which should ensure good supplies. The London Metal Exchange statement also gives the maximum prices fixed for copper, lead, and spelter, and is as follows :—

| | |
|---|---|
| STANDARD TIN ... | Cash (Mean) £240 18s. 0$\frac{1}{2}$d. |
| | 3 Months (Mean) £240 9s. 1$\frac{1}{2}$d. |
| | Settlement (Mean) £240 17s. 6d. |

The following prices for copper, lead, and spelter are the maximum prices fixed by the Controller of Non-Ferrous Metals :—

| | £ | s. | d. | |
|---|---|---|---|---|
| STANDARD COPPER— | | | | |
| Electrolytic Copper ... | 62 | 0 | 0 | delivered buyers' premises |
| Electrolytic Wire Bars ... | 62 | 0 | 0 | delivered buyers' premises |
| Best Selected Copper ... | 60 | 10 | 0 | delivered buyers' premises |
| Lead—Good Soft Pig ... | 25 | 0 | 0 | delivered buyers' premises |
| (Foreign) | | | | (duty paid) |
| Spelter—G.O.B. ... | 25 | 15 | 0 | delivered buyers' premises |
| (Foreign) | | | | (duty paid) |

FUSION WELDED STEAM PRESSURE VESSELS.—In June 1938, some of the engineering insurance offices prepared a "Schedule of Examinations and Tests during Construction and upon Completion of Metallic Arc Welded Drums for Steam Generating Units and Steam Receivers." As a result of the considerable demand by users of welded pressure vessels for a fixed code of construction, the Technical Committee has now issued a booklet "Rules for the Construction, Testing, and Scantlings of Fusion Welded Steam Pressure Vessels" which, with the schedule, forms a comprehensive code covering three classes of vessel. We have received a copy of the rules from the Vulcan Boiler and General Insurance Company, Ltd., one of the engineering insurance companies concerned which acts as an inspecting authority.

# French Engineering Notes

(*From our own Correspondent in Paris*)

## Workers' Collaboration

THE idea of bringing workers into collaboration with employers did not come originally from either of the parties concerned, although such collaboration had existed in some small enterprises on the verge of bankruptcy where the men agreed to sacrifices in order to effect a recovery with the promise of participation in future profits. These and other examples of workers' participation in profits do not express the idea of collaboration as now understood and are, at present, far from being crystallised into a definite plan to suit general conditions. Economic groups endeavour to solve a complex problem on lines that will improve the workers' social status and give them an incentive to take a personal interest in their occupation. Collaboration means attaching men to their work by social advantages and remunerating them for their contribution to the general progress of the enterprise in which they are engaged. The workers' skill and initiative are to be utilised as fully as possible. The custom has long been adopted by many firms of inviting men to submit ideas for improvements in workshop practice and methods for which they are paid, if used, and it is suggested that this custom may be extended to cover production in a manner to increase output and lower costs by an organised system that will remunerate the men for their efforts to give more value to the enterprise. It is not expected that any plan can be devised that may at once be put into operation. The plan can only be evolved progressively by makers' federations with the experience of individual members. All of them feel that something must be done as soon as possible to bring them into closer association with the men. Until now there has been no reaction by labour unions, which maintain an attitude of reserve during hostilities, but a recent pronouncement of the general secretary of the Confédération Générale du Travail, Monsieur Jouhaux, leaves no doubt of his attitude towards such a collaboration between employers and workers. His idea is that the Confederation must solve the problem of collaboration between labour, the State, and employers. So long as the Popular Front Government existed most of the labour unions only accepted the authority of that Government, which had elected Monsieur Jouhaux as sole representative of the working community. This coupling of the State with the task of collaboration means that with a Socialist Government in power the Confederation expects to have an ally in recovering some of the authority over employers which it lost when the great majority of workers refused to be led into a general strike as a sequence to the extremist agitation that had proved disastrous to them. While manufacturers are seeking direct collaboration with the men, the Confédération Générale du Travail is examining with the T.U.C. plans for carrying out an international labour policy after the war.

## Steel Production

Some interesting references to the effect of the mobilisation upon the steel making industry were made by Monsieur Theodore Laurent at the annual meeting of the Aciéries de la Marine et d'Homécourt, of which he is president, when he stated that the company's steel production fell from 33,125 tons in July, to 20,600 tons in September. Following upon the organisation of national production by the Minister of Armaments the company was able to increase its steel output and was required by the Minister to extend its steelmaking plant with financial facilities provided by the State. Monsieur Laurent affirmed that the French monthly production will exceed 800,000 tons during the peak year of 1929 and will be something like 840,000 tons. At the same time, the limitation of selling prices without taking adequately into account factors of increasing costs, such as abnormal wear and tear of machinery and plant, is seriously perturbing steel makers, who accept this State control during hostilities and are yet wondering where it will led to after the war. It may be idle at the moment to speculate upon what may happen, but in the light of what occurred in the recent past there is fear that the State, having controlled the entire national production under emergency conditions, may be little disposed to relinquish that control altogether when the necessity for it no longer exists. In any case, if the Government decides that the present organisation must be continued in a modified form in order to tide over possible post war difficulties it will necessarily exercise control, and if carried too far manufacturers fear that they will be deprived of freedom of initiative, without which capital will abstain from participating in industry. Monsieur Laurent expressed the opinion that the situation is a serious one as regards the future collaboration of capital and will, he said, compromise the vital interests of industry, and be detrimental to the national interest, if the warning is ignored.

## Suction Gas Lorries

The Minister of National Defence has made it known that the whole production of lorries of 1500 kilos and more has been monopolised by the War Department, with the exception of 200 chassis a month that will be sold to private buyers who undertake to equip them to run on suction gas. One reason for this offer appears to be that many users are disinclined to convert old lorries that are hardly worth the cost of fitting producer plants. While there continues to be a rationing of petrol for commercial vehicles the number of lorries on the road has fallen considerably because the supplies are not usually sufficient and the increased cost of petrol imposes an additional burden on lorry users. Many of them have had their lorries requisitioned. These difficulties are bound to increase until owners will be compelled to convert lorries to run on suction gas if they are not to risk losing them altogether. Another trouble is that the production of reliable suction gas producers can hardly be expected to meet the demands of all lorry owners requiring them for some time to come. It has been suggested that there should be a State organisation to control and facilitate the manufacture of producers and provide means of converting lorries in different regions all over the country so that owners may be assured of the work being carried out promptly and satisfactorily.

# British Patent Specifications

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

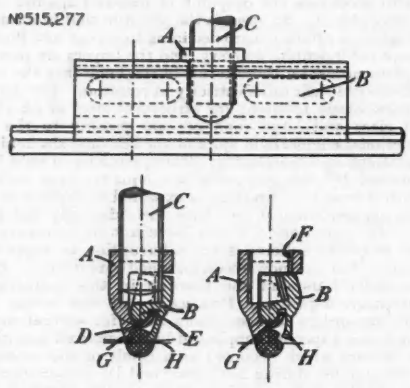
*Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.*

*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## TRAMWAYS AND RAILWAYS

515,277. May 28th, 1938.—CLAMPS FOR SUSPENDING AND ANCHORING OVERHEAD WIRES FOR ELECTRIC RAILWAYS AND TRAMWAYS, Mario Baffico, 80, Corso Firenze, Genova, Italy, and Giuseppe Federico Siccardi, of 40, Via Venti Settembre, Genova, Italy.

The clamp is composed of three elements: a fixed part A, a moving part B, and a closure element C. The moving part can be made to turn about the hinge formed by the parts D and

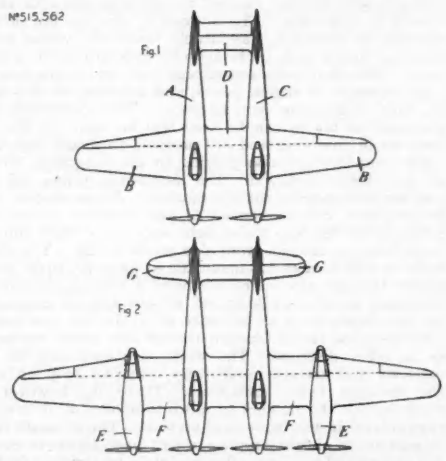



E so as to effect the closing of the clamp. The element C, in order to engage and be guided in a threaded opening F formed in the upper portion of the fixed part of the clamp, has the form of a threaded shank. In the embodiment illustrated, the moving portion, under the action of the threaded shank, turns by pivoting on the fixed portion and the projections G and H consequently grip the wire of the overhead line.—*November 30th*, 1939.

## AERONAUTICS

515,562. July 1st, 1938.—IMPROVEMENTS RELATING TO THE STRUCTURE OF AIRCRAFT, the Fairey Aviation Company, Ltd., North Hyde Road, Hayes, in the County of Middlesex, and Marcel Jules Odilon Lobelle, of "Ludlow," 298, Langley Road, Langley, Bucks.

It has already been proposed to construct aircraft having engines mounted in detachable wing sections which may be secured on one side to the root of the wing and on the other side to a detachable wing proper; it has also been proposed to construct biplanes having detachable wings which may serve as upper or lower wings on either side of the machine. The present invention consists in a detachable wing aircraft having wings which may be secured directly to a fuselage by standard securing means, wherein the aircraft is convertible into a twin fuselage aircraft by the provision of an auxiliary fuselage and centre sections for the main- and tail-planes adapted to be secured between and directly to the fuselages by standard




securing means. Referring to the drawings, a detachable-wing aircraft having a fuselage A, detachable wings B, and detachable tail-planes secured together by standard securing means of known type may be converted into a twin fuselage aircraft by the provision of a second fuselage C and centre sections D for the main- and tail-planes respectively. It is to be understood, however, that it is an important feature of the invention that to ensure ease of assembly and interchangeagility the securing means must be standardised. This twin fuselage construction may be extended to multi-engined craft, such as that shown in Fig. 2, where integral engine nacelles E, and wing-sections F are added to the fuselages A and C and tail-planes G are employed on either side of the tail-plane centre section. It will be appreciated that although the fuselages have been shown as having engines, multi-engined craft as shown in Fig. 2 may be built up from components having engines in the nacelles E only.—*December 7th*, 1939.

# PERSONAL AND BUSINESS ANNOUNCEMENTS

RUSTON AND HORNSBY, Ltd., Lincoln, have acquired the whole of the share capital of Davey Paxman and Co. (Colchester), Ltd., oil engine builders and boiler manufacturers. The business will be continued as heretofore, under the Managing Directorship of Mr. E. P. Paxman. The products of the two companies are complementary and the object of the acquisition is to enlarge the joint range of manufactures to the mutual advantage of both businesses in meeting post-war conditions and in consolidating their position in world markets.

# Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### Air Raid Protection Institute

*Tuesday, Feb. 13th.*—Royal Society of Arts, John Street, Adelphi, W.C.2. "The Design and Installation of Services in Shelters," N. Forster. 8 p.m.

### Chemical Engineering Group

*Friday, Feb. 16th.*—Chemical Society's Rooms, Burlington House, Piccadilly, W.1. "The Chemical Plant Manufacturer in Relation to Chemical Industry," B. N. Reavell and G. E. Foxwell. 2.30 p.m.

### Institute of British Foundrymen

*Wednesday, Feb. 14th.*—Lancs. Branch. Engineers' Club, Albert Square, Manchester. "Some Interesting Features of the Non-Ferrous Foundry," F. Hudson. 7 p.m.

### Institute of Fuel

*Thursday, Feb. 22nd.*—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Modern Gas Storage," S. Thomson. 2.15 p.m.

### Institution of Automobile Engineers

*Tuesday, Feb. 13th.*—Luton Centre. George Hotel, Luton. "Some Anti-Friction Bearing Problems," M. J. Knagge. 7.30. Coventry Centre. Kings Head Hotel, Coventry. "The Theory of Flexible Mountings for Internal Combustion Engines," C. B. Iliffe. 7 p.m.

*Wednesday, Feb. 14th.*—Manchester Centre. Engineers' Club, Albert Square, Manchester. Informal Discussion. 7.15 p.m.

*Monday, Feb. 19th.*—Glasgow Centre. Inst. of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow. "The Use of Gas as a Fuel for Motor Vehicles," J. S. Clarke. 7.30 p.m.

*Wednesday, Feb. 21st.*—Leeds Centre. Hotel Metropole, Leeds. "Some Problems we Meet," L. H. Dawtrey. 6 p.m.

### Institution of Chemical Engineers

*Tuesday, Feb. 13th.*—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Sedimentation and Flocculation," M. B. Donald. 2.15 p.m.

### Institution of Electrical Engineers

*Wednesday, Feb. 14th.*—South Midland Students. Kunzles Cafe, Union Street, Birmingham. 7 p.m.

*Thursday, Feb. 22nd.*—Savoy Place, Victoria Embankment, W.C.2. "Insulation Stresses in Transformers, with special reference to Surges and Electrostatic Shielding," H. L. Thomas. 6 p.m.

### Institution of Engineers and Shipbuilders in Scotland

*Tuesday, Feb. 20th.*—39, Elmbank Crescent, Glasgow. "Welding as a Substitute for Casting," S. F. Dorey. 6.30 p.m.

### Institution of Mechanical Engineers

*Friday, Feb. 16th.*—Storey's Gate, Westminster, S.W.1. Annual General Meeting. Presidential Address "The Influence of the Mechanical Mind on the Development of Irrigation throughout the Ages," E. Bruce Ball. 2.30 p.m.

*Saturday, Feb. 17th.*—Yorkshire Branch. The University, St. George's Square, Sheffield. "A Review of Forty Years' Development in Mechanical Engineering Plant for Power Stations," Sir Leonard Pearce. 2.30 p.m.

### Institution of Mining Engineers

*Saturday, Feb. 10th.*—Royal Victoria Station Hotel, Sheffield. Annual General Meeting. Presidential Address, E. O. Forster Brown. "Mine Supports during War Time," A. M. Bryan, M. A. Hogan, and J. A. S. Ritson. 11 a.m.

### Institution of Production Engineers

*Tuesday, Feb. 13th.*—Birmingham Graduates. James Watt Memorial Institute, Birmingham. "Metal Cutting Fluids," C. F. Gazard. 7 p.m.

*Wednesday, Feb. 14th.*—Preston Section. Harris Institute, Corporation Street, Preston. "Progress in Machine Tool Design," R. C. Fenton. 7.30 p.m.

*Tuesday, Feb. 20th.*—Mostyn Hotel, Portman Square, W.1. "Modern Instruments of Measurement and the Principles of their Design," G. Schlesinger. 7.30 p.m. Eastern Counties Section. Public Library, Ipswich. "Conveying Systems as Applied to Present Day Production Methods," A. Clarke. 7.30 p.m.

*Tuesday, Feb. 20th.*—Luton Section. Queen's Engineering Works, Bedford. "Time Measuring Installations," J. S. Godman. 7.30 p.m.

### Junior Institution of Engineers

*To-day, Feb. 9th.*—39, Victoria Street, S.W.1. "The History and Development of Lubricated Plug Valves," P. Meredith. 6.30 p.m.

### Manchester Association of Engineers

*To-day, Feb. 9th.*—College of Technology, Sackville Street, Manchester. "The Use of Models in Engineering," A. H. Gibson. 7.30 p.m.

### North-East Coast Institution of Engineers and Shipbuilders

*To-day, Feb. 9th.*—Mining Institute, Newcastle-upon-Tyne. "The Application of the Heavy-Oil Engine to Aircraft Propulsion," W. S. Burn. 6 p.m.

*Friday, Feb. 16th.*—Student Section. Bolbec Hall, Newcastle-upon-Tyne. "Electrical Measurement of Mechanical Quantities," W. W. Campbell. 6.45 p.m.

### Royal Institution of Great Britain

*To-day, Feb. 9th.*—21, Albemarle Street, W.1. "Ultra-Violet and Electron Microscopy," L. C. Martin. 5 p.m.

*Tuesday, Feb. 13th.*—21, Albemarle Street, W.1. "Present Day Study of the Stars," Sir J. Jeans. 3 p.m.

*Wednesday, Feb. 14th.*—21, Albemarle Street, W.1. "X-Ray Optics," W. L. Bragg. 5.15 p.m.

*Thursday, Feb. 15th.*—21, Albemarle Street, W.1. "Measurement of Gravity," A. O. Rankine. 3 p.m.

*Friday, Feb. 16th.*—21, Albemarle Street, W.1. "Physics in War Time," Sir W. Bragg. 5 p.m.

### Sheffield Society of Engineers and Metallurgists, Sheffield Metallurgical Association, Iron and Steel Institute

*Tuesday, Feb. 20th.*—Grand Hotel, Sheffield. "Oxygen Determinations on a Series of Bath Samples taken from an Acid Open Hearth Furnace." G. E. A. Bramley and G. Tateson. "Tensional Effects of Torsional Overstrain in Mild Steel," Prof. H. W. Swift. "A study of a Nickel Chromium-Molybdenum-Vanadium Steel Ingot." Dr. W. H. Hatfield. 7.30 p.m.